Chapter 1 : Toxic substance profile: Algal toxins and algae-related fish kills

The conference on The Water Environment: Algal Toxins and Health was held at Wright State University in Dayton, Ohio, on June 29, 30, July 1, 2, Its principal objectives were to bring.

Published online Apr Beasley 2 Elizabeth D. Received Jan 27; Accepted Apr This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license http: This article has been cited by other articles in PMC. Abstract Harmful cyanobacterial blooms have adversely impacted human and animal health for thousands of years. Recently, the health impacts of harmful cyanobacteria blooms are becoming more frequently detected and reported. However, reports of human and animal illnesses or deaths associated with harmful cyanobacteria blooms tend to be investigated and reported separately. Consequently, professionals working in human or in animal health do not always communicate findings related to these events with one another. Using the One Health concept of integration and collaboration among health disciplines, we systematically review the existing literature to discover where harmful cyanobacteria-associated animal illnesses and deaths have served as sentinel events to warn of potential human health risks. We find that illnesses or deaths among livestock, dogs and fish are all potentially useful as sentinel events for the presence of harmful cyanobacteria that may impact human health. We also describe ways to enhance the value of reports of cyanobacteria-associated illnesses and deaths in animals to protect human health. Efficient monitoring of environmental and animal health in a One Health collaborative framework can provide vital warnings of cyanobacteria-associated human health risks. Freshwater Cyanobacteria Freshwater cyanobacteria and their toxins cyanotoxins pose risks to human and animal health via contamination of water sources and aquatic communities globally. The World Health Organization has developed guidelines based upon cyanobacterial cell densities in water, and advises that the presence of dense scums near bathing areas may indicate substantial human health risks [2]. Although cyanobacteria are naturally-occurring, anthropogenic activities now contribute to increased occurrence of HABs globally [3]. Nutrient pollution from human and animal wastes that wash into surface waters, fertilizer applications, atmospheric nutrient deposition, burning of plant material, overgrazing, warmer weather, drought conditions that reduce terrestrial plant uptake of nutrients as well as reduce the depth and flow of water bodies all contribute to bloom formation [4]. Conditions that promote cyanobacteria occurrences are expected to increase based upon model projections of future human population growth, land use patterns and climate change [5]. Many genera of cyanobacteria produce potent toxins as secondary metabolites, some of which are released before, and others largely after, cyanobacterial lysis. The evolutionary value of cyanotoxins to their producers is not fully characterized, although benefits may include: Cyanobacteria often produce foul taste and odor compounds such as geosmin and 2-methylisoborneol during their life cycle, senescence and decomposition [9 , 10]. These taste and odor compounds are not believed to present major health risks, but their potential toxicity has been little studied [11]. Importantly, these odorous compounds can indicate the need to prevent human and animal exposure to water that may also contain potentially lethal cyanotoxins [9]. During the 19th and most of the 20th century, the toxicity of water samples was assessed primarily by the use of the animal bioassay. Francis, in authored one of the first reports of the toxicological assessment of a harmful cyanobacterial bloom and the intentional use of an animal as an indicator of human health risk [12]. During the last years, advances in investigative and diagnostic tools have helped characterize cyanobacteria and cyanotoxins, including: During the latter part of the 20th century, over unique cyanotoxins have been identified, and new compounds continue to be isolated, and structurally characterized. Multiple functional classes of cyanotoxins have now been described, including: Examples of hepatotoxins include the cyclic peptides: Cylindrospermopsin is a potent sulfated tricyclic guanidine cytotoxin with bioactive metabolites. Cyanobacterial neurotoxins include saxitoxin and neosaxitoxin, which are complex alkaloid sodium channel blockers, the cyclic alkaloid nicotinic agonists anatoxin-a and homoanatoxin-a, and the organophosphorus cholinesterase inhibitor anatoxin-a s. Lyngbyatoxins are cyanobacterial dermatotoxins that occur in fresh, brackish, and marine waters. Cyanobacteria also produce lipopolysaccharides, which are general irritants [18]. No cyanotoxins are fully characterized for toxicity, for geographic occurrence, or for the environmental conditions necessary and sufficient for their production. Concerted research efforts are underway in many countries to characterize the occurrence of harmful cyanobacteria and their effects on ecosystem functions as well as human and animal health. However, the number of cyanotoxins and combinations of cyanotoxin mixtures in the environment complicates risk assessments focused on potentially harmful cyanobacterial exposures. Nevertheless, the concept of One Health as a more inclusive and holistic way to study and maintain health within a cross-species continuum is ancient. In the s, Rachel Carson made connections between the application of highly toxic pesticides and adverse effects on human, domestic animal, and terrestrial and aquatic wildlife health. A One Health approach would have benefitted all of those involved in an incident of methylmercury intoxication in Japan in the s [22]. A prolonged industrial release of methylmercury into waters off the coast of Minamata poisoned first fish and then birds; later cats and thousands of humans were sickened as the toxin spread throughout the food web. One Health insights relevant to infectious diseases were relied upon by such scientists as Edward Jenner, when, in developing a vaccine against smallpox a human disease , he demonstrated the cross reactivity of human antibodies between smallpox and the less pathogenic cowpox an animal disease. In short, One Health is a paradigm that recognizes the interdependence of human, animal, plant, microbial, and ecosystem health [23]. Effective multidisciplinary research, surveillance, and stewardship are essential for synchronous improvements in the health of humans, other animals, plants and ecosystems [19]. Recently, funding for public health from public and private sources has declined [24 , 25]. Unfortunately, this has coincided with reductions in essential public health services provided by functional ecosystems [26]. The One Health framework offers an interdisciplinary paradigm that seeks to optimize health by leveraging existing resources and capabilities among human, veterinary and ecosystem health experts to address some of the most the complex, multidisciplinary challenges that define the 21st century. Reports of human health and animal health tend to be published separately and are discussed separately. However, harmful cyanobacteria impact both humans and animals. Animals often experience direct, high-intensity exposures to harmful cyanobacteria which result in illnesses and deaths. Cyanobacteria-associated animal illnesses or deaths can therefore be used to warn of risks and if heeded, action may be implemented to avoid adverse human health effects [27]. Our goal is to provide a representative overview of the adverse effects of harmful freshwater cyanobacteria on humans and other vertebrates and to comprehensively review reports that include incidents where animal illnesses and deaths have served as sentinel events to warn of potential or actual human health risks. Selected Human Health Reports Human health may be adversely impacted by harmful cyanobacteria from many sources, and via multiple routes of exposure. The highest impact outbreaks of cyanobacteria-associated intoxications and deaths have been reported when patients requiring hemodialysis were directly exposed to cyanotoxins intravenously via dialysate prepared from contaminated water [28 , 29]. This route of exposure to cyanotoxins resulted in toxic hepatitis, multi-organ damage and death [28 , 29 , 30 , 31]. People are most frequently exposed to harmful cyanobacteria via contaminated water. People may be exposed orally, dermally and occasionally by aspiration to aquatic microbial communities containing cyanobacterial cells and mixtures of cyanotoxins during recreational activities on or in untreated surface waters [32 , 33 , 34 , 35 , 36]. Occasionally, these exposures have resulted in severe respiratory impairment characterized by pneumonia and adult respiratory distress syndrome [32 , 35]. Less severe effects include fever, other respiratory illness, signs and symptoms of respiratory and dermal allergy, and dermatologic, gastrointestinal, neurologic, otic, and ocular signs and symptoms [33 , 34 , 36 , 37 , 38 , 39 , 40 , 41 , 42 , 43]. Occupational exposures to harmful cyanobacteria have been reported after routine work on an incidentally contaminated surface water body, in relation to investigation of a cyanobacterial bloom, and following an investigation of cyanobacteria-associated animal illnesses and deaths [34]. Drinking water contaminated with harmful cyanobacteria has been associated with liver and kidney damage [44 , 45], and rarely, severe illness, extended hospitalizations and deaths have occurred [45 , 46 , 47]. Acute health effects such as gastroenteritis, muscle pain and dermatitis associated with home use of contaminated drinking water have been reported [43 , 48]. When municipal systems have been contaminated, large numbers of people may be exposed and become ill [49 , 50 , 51 , 52 , 53]. The International Agency for Research on Cancer has determined that, while current data on microcystins and nodularins are inconclusive in regard to human carcinogenesis, promotion of liver tumors by these toxins is plausible [54]. Zhou [55] reported that use of potentially microcystin-contaminated drinking water supplies was associated with higher rates of colorectal cancer in human populations in parts of China. Conventional drinking water treatment involving filtration, flocculation, and disinfection reduces, but does not always eliminate cyanobacteria and cyanotoxins. More sophisticated methods may be required to reduce cyanotoxins in finished drinking water to acceptable concentrations [56]. However, drinking water treatment processes may become impaired or ineffective when large quantities of cyanobacterial biomass enter the source water intake. Some poorly characterized human health risks include: Selected Animal Health Reports HABs and associated adverse animal health impacts have been recorded for over years. The first published report believed to document a harmful cyanobacteria bloom was by Hald to the Danish government in The bloom material itself was uncharacterized. Most early reports of animal deaths associated with harmful blooms were circumstantial. Waters were initially suspected of being harmful because of the temporal and spatial proximity of dead and dying animals observed in and around a bloom. Francis was the first to scientifically investigate the toxic effects of a cyanobacterial bloom [12]. After mass livestock deaths in Lake Alexandrina in Australia, he administered a sample of the Nodularia spumigena bloom material from the lake to a sheep. He then compared necropsy results of the animal experimentally exposed with sheep that had died following natural exposure to the bloom and concluded that cyanobacteria were the source of the toxic effects. Harmful cyanobacteria adversely affect wildlife, livestock and companion animals. Schwimmer and Schwimmer [64] compiled and summarized over 65 wildlife, livestock and domestic animal mortality events associated with cyanobacteria during â€” Animal deaths associated with harmful cyanobacteria have been reported from Europe, North America, South America, Australia, Africa and Asia [12 , 65 , 66 , 67 , 68 , 69]. Reports of livestock deaths following exposures to cyanobacteria under field conditions have been reported from every inhabited continent and involved ruminants, hogs, horses, fowl, cultured fish and even honeybees [65 , 66 , 71 , 72 , 73 , 74 , 75]. Antemortem signs of intoxication vary and are dependent upon the cyanotoxins, the dose and time frames involved, the therapeutic interventions employed and individual characteristics of the exposed animals. Acute effects often include: Birds may display weakness and neurologic signs such as ataxia, and hyperextended necks opisthotonos prior to death. Cyanobacteria have been associated with mass mortality events in catfish and carp cultured in ponds; microcystins in water were accompanied by clinical signs of illness and gross lesions in the liver [73 , 75]. Because of microcystin residues, the latter authors Singh and Asthana cautioned against human consumption of the tissues of contaminated fish. Reports of cyanobacteria-associated companion animal illnesses and deaths have most often involved dogs. Dogs have been observed consuming scums of cyanobacteria that accumulate near the shore, drinking contaminated water, and licking bloom material from their hair coats after wading or swimming [80]. A recent summary of cyanobacteria-associated dog deaths in the United States compiles over reports over the last 80 years [81]. The frequency of reporting of these events has greatly increased since the s, however, reporting, attribution and detection biases were all factors that influenced the number of events that were confirmed as being associated with cyanobacteria during the study period. Deaths among other companion animal deaths such as cats are rarely reported [77]. Acute effects among companion animals include: Wildlife deaths associated with harmful freshwater cyanobacterial blooms are commonly reported, but undoubtedly many occur and are unreported because of the lack of human observation of the event. Multiple types of vertebrates may be harmed, from fish to birds to mammals [84 , 85 , 86]. In some instances it is not always possible to attribute wildlife deaths to harmful cyanobacteria because when the affected animals are found, they are too decomposed for reliable pathological and toxicological analyses. Fish and water birds are at especially high risk of harmful cyanobacteria-associated effects, and mass mortality events have been reported from most continents [66 , 68 , 85 , 87 , 88]. Cyanobacteria blooms may have direct and indirect adverse effects on fish and water birds. Direct intoxication may occur after exposure to harmful cyanobacteria, or cyanotoxin-contaminated food and water. Indirect effects of cyanobacterial blooms include a decrease in dissolved oxygen and the proliferation of Clostridium botulinum [89]. Large mortality events have occurred when birds are poisoned by botulinum toxin in aquatic environments [90 , 91].

Chapter 2 : OGRL Algal Toxins Methods of Analysis

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

Potential effects on interest features of European marine sites Entry to the marine environment Algal toxins do not enter the marine environment from an external source but are generated during blooms of particular naturally occurring marine algal species. Such blooms have been referred to as toxic algal blooms, harmful algal blooms HABs and red tides. For example Gyrodiunium aureolum causes a red discolouration of the water a red tide and has been associated with shellfish and fish mortalities, particularly in marine fish farms. Chaetoceros, another alga, has spines which can physically clog and damage fish gills, leading to the death of cage-reared salmon and other species. Other algal species, such as Alexandrium and Dinophysis can cause poisoning through the food chain when shellfish ingest these algae and their toxins and are then subsequently consumed by fish, birds and potentially humans Environment Agency Algal toxins can give rise to a number of different poisoning syndromes: Some species of microflagellates may also produce toxins, e. A fifth human illness, ciguatera fish poisoning CFP , is caused by benthic dinoflagellate toxins in coral reef communities. However, this does not represent a problem in UK waters. The principal concern about the effects of algal toxins in the environment has been the contamination of sea food for human consumption and consequently much of the research and monitoring is directed at protecting humans from these effects. There must also be concerns on the effects of these toxins on natural populations of consumers fish, birds and marine mammals. The results of this monitoring is reported annually e. Monitoring takes the form of the analysis of water samples for the presence and concentration of toxic algal species and the measurement of concentrations of algal toxins in samples of shellfish flesh. Standards for concentrations of algal toxins in shellfish flesh so-called end product standards have been set in The Food Safety Fishery Products and Live Shellfish Regulations as a requirement of the Shellfish Hygiene Directive. Breaches of these standards can result in the closure of a particular fishery for a period of time. It is very difficult with current knowledge to determine the likelihood of toxic algal bloom occurrence, since bloom occurrence appears to be only loosely linked to nutrient levels if at all , although it has been suggested by a number of authors that changes in salinity can stimulate either the growth or decline of toxic blooms. Other factors that have been cited for the reported increased occurrence of harmful algal blooms include increased awareness and monitoring especially in relation to the effects on aquaculture , climate change and the transport of toxic algal species in the ballast tanks of vessels. Toxic dinoflagellate species also overwinter by forming spores which settle on the sea bed. These germinate and provide the inoculum for bloom development in future years. Consequently, once a toxic bloom has occurred for the first time, there is an increased risk of toxic bloom development at the same site in future years. Dinoflagellate spores remain viable for a relatively long period of time certainly several, and perhaps tens, of years. Fate and behaviour in the marine environment Algal toxins are naturally occurring compounds that are released into the environment, either when algal cells are ingested by filter feeding animals, or when algal cells are broken down after a bloom crashes. The fate and behaviour of these toxins in the marine environment is not well known but they will undergo microbial biodegradation when released into the environment. Some dinoflagellate species of toxic algae form cysts that can accumulate in the sediment and act as an inoculum for a new population when conditions favour germination of the cysts. Effects on the marine environment Effects on marine organisms An exhaustive literature review on the effects of algal toxins to marine organisms has not been carried out for the purposes of this profile. The information provided in this section is taken from existing general information and selected references. The direct effects of blooms of toxic algae on marine organisms include: Toxic phytoplankton can be filtered from the water by shellfish, such as clams, mussels, oysters, or scallops, which then accumulate the algal toxins to levels which can be lethal to consumers, including humans Shumway , Ahmed Typically, the shellfish are only marginally affected, even though a single clam can sometimes contain sufficient toxin to kill a human. Fish and shellfish can also be subject to sub-lethal effects, including increased susceptibility to disease and reduced growth. Fish can be affected by algal toxins, either by direct uptake from the water column planktivorous fish or by bioaccumulation through the food chain zooplankton and macroinvertebrates. In turn, these fish can then endanger whales, porpoises, seabirds, and other animals. In addition to toxin production, algae have also been implicated in fishkills by the following direct methods: Mechanical damage to gills by algal spines, notably the serrated spines of Chaetoceros spp. Yang and Albright Irritation of gills resulting in over-production of mucilage within the gills leading to suffocation WHOI Physical blocking of the secondary lamellae of fish gills Jones and Rhodes Increased water viscosity due to the secretion of polysaccharides e. The principal indirect effects arise from changes in the oxygen balance of the water column associated with the presence of the bloom during its growth phase supersaturation with oxygen during the day and oxygen depletion during the night and the decay of the algal cells when the bloom has crashed oxygen depletion of parts of the water column and possibly the sediments. Algae have been implicated in fishkills by the following indirect methods: Asphyxiation caused by oxygen depletion e. Brooker et al This can occur as a result of the oxygen demand generated by a senescent bloom, or at night due to extreme diurnal fluctuations in dissolved oxygen levels which may occur during algal blooms. Gas bubble trauma from extreme oxygen supersaturation Renfro Bioaccumulation Many algal toxins readily bioaccumulate in marine animals and significantly biomagnify through food chains posing a hazard to consumers at higher trophic levels fish, birds and sea mammals. Potential effects on interest features of European marine sites Potential effects include: A precautionary approach to determining the scale of possible impacts of algal toxins should be adopted if the presence of toxic algal species or algal toxins is detected in a European marine site ; adverse physical effects on fish because of the presence of harmful algal blooms; hazards to all marine organisms resulting from changes to the oxygen balance of the water column, and potentially the sediments, both during and after a harmful algal bloom.

Chapter 3 : Harmful Algal Blooms | Nutrient Pollution | US EPA

The conference on The Water Environment: Algal Toxins and Health was held at Wright State University in Dayton, Ohio, on June 29, 30, July 1, 2, Its principal objectives were to bring together, for the first time, researchers, public officials and interested parties in order to present and.

Opinion Toxic blue-green algae in irrigation waters: Over the past several decades, as a result of warming and pollution from anthropogenic climate change, Australian freshwater bodies have experienced increases in the density and distribution of harmful cyanobacterial blooms cyanoHABs. Their extensive evolutionary history has allowed them to dominate in a range of aquatic environments, from acidic freshwater to alkaline seas. A sizable percentage of cyanobacteria are toxic. The most common cyanotoxins are hepatotoxins from Greek hepato-, liver and neurotoxins from Greek neuro-, nervous system. The hepatotoxins consist of microcystin, nodularin, and cylindrospermopsin, named after their initial discovery in cyanobacterial genera Microcystis, Nodularia, and Cylindrospermopsis, respectively, however, they are produced by a range of other cyanobacteria as well. These potentially fatal toxins highlight a great need to understand how their presence in irrigation water may threaten public health, as cyanotoxins have been found to bioaccumulate in the roots and shoots of many crops. Cyanobacterial toxins as classified by their methods of toxicity, dominant toxin-producing genus, and associated symptoms. There is extensive scientific literature on the accumulation of cyanotoxins in plants and crops irrigated with water containing cyanobacterial blooms. Certain crops, such as lettuce, may retain actual colonies of toxic cyanobacteria on their edible parts after spray irrigation with water containing cyanoHABs, as irrigation water is very rarely treated for cyanobacteria or toxins, and these colonies are not removed with the washing and rinsing typical of household vegetable preparation. I conducted a two-season study to determine the presence of toxic cyanobacteria in six irrigation sources from the Hawkesbury-Nepean River Figure 1. Geographic distribution of sampling sites in Hawkesbury-Nepean catchment from water intended for irrigation. The yellow text indicates storage and the white text indicates locations on the river. Water samples were collected, the organisms filtered, and their DNA extracted for use in PCR amplification and Next-Generation Sequencing to detect the presence of genes involved in the biosynthesis of cyanotoxins and identify toxic cyanobacterial species. The bloom was associated with prominent levels of turbidity, alkalinity, dissolved organic matter, dissolved solids, warm surface temperatures, and vertical stratification of the water column. Genes involved in microcystin and saxitoxin production were also discovered among the samples and varied on a spatiotemporal scale. The presence of the latter genes, detected only in autumn, also indicated a temporal shift in water quality properties that were favourable to the proliferation of additional species of cyanobacteria as indicated by toxin-producing genes. Of the several species of toxic cyanobacteria identified among the samples, the dominance of BMAA-producing marine species Prochlorococcus marinus was of particular interest as it was thriving in a freshwater environment, which is highly unusual and has not been discovered in any known literature. Other toxic species included microcystin-producing Microcystis panniformis and Calothrix parietina. The presence of toxin-producing cyanobacteria in irrigation sources from the catchment indicates a high probability that crops are being irrigated with water containing cyanotoxins, but further research is needed to confirm this, including determining the presence and concentration of toxins in water as bioaccumulation is directly related to concentration. Further research and greater replication is needed to confirm these results and may consider the inclusion of benthic cyanobacteria, or those that dwell in bottom sediments, to obtain a holistic picture of total cyanobacteria in the water column. Additionally, factors that may be contributing to the proliferation of Prochlorococcus marinus should be investigated to determine why a marine cyanobacterial species is dominant in a freshwater environment. This study contributes to an existing dataset on the biogeography of toxic cyanobacteria in Australia and provides a platform on which future research may be conducted to assist in making informed managerial decisions on the safety of using untreated water from the Hawkesbury-Nepean catchment as an irrigation source. Toxicology and Applied Pharmacology, 3 , Lettuce irrigated with contaminated water: Photosynthetic effects, antioxidative response and bioaccumulation of microcystin congeners. 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Marine Drugs, 8 5 , Her research interests include food security, water quality, hydrology, and public health, which were incorporated in her research thesis on toxic cyanobacteria in irrigation water that she undertook in July Kansas is returning to the United States to pursue a career in environmental science.

Chapter 4 : Saxitoxin hydrochloride | C10H19Cl2N7O4 - PubChem

That water -- and the nutrients found in it -- are rerouted, often toward ponds on farm property, said study co-author Seungjun Lee, a postdoctoral researcher in environmental health sciences at.

Blooming[edit] Algal blooms can present problems for ecosystems and human society. For some species, algae can be considered to be blooming at concentrations reaching millions of cells per milliliter, while others form blooms of tens of thousands of cells per liter. The photosynthetic pigments in the algal cells determine the color of the algal bloom, and are thus often a greenish color, but they can also be a wide variety of other colors such as yellow, brown or red, depending on the species of algae and the type of pigments contained therein. Bright green blooms in freshwater systems are frequently a result of cyanobacteria colloquially known as "blue-green algae" as a result of their confusing taxonomical history such as Microcystis. Blooms may also consist of macroalgal non- phytoplanktonic species. These blooms are recognizable by large blades of algae that may wash up onto the shoreline. Of particular note are the rare harmful algal blooms HABs , which are algal bloom events involving toxic or otherwise harmful phytoplankton such as dinoflagellates of the genus Alexandrium and Karenia, or diatoms of the genus Pseudo-nitzschia. Such blooms often take on a red or brown hue and are known colloquially as red tides. Freshwater algal blooms[edit] Further information: Nutrient pollution and Eutrophication Freshwater algal blooms are the result of an excess of nutrients , particularly some phosphates. They may also originate from household cleaning products containing phosphorus. Presence of residual sodium carbonate acts as catalyst for the algae to bloom by providing dissolved carbon dioxide for enhanced photosynthesis in the presence of nutrients. When phosphates are introduced into water systems, higher concentrations cause increased growth of algae and plants. Algae tend to grow very quickly under high nutrient availability, but each algal is short-lived, and the result is a high concentration of dead organic matter which starts to decay. The decay process consumes dissolved oxygen in the water, resulting in hypoxic conditions. Without sufficient dissolved oxygen in the water, animals and plants may die off in large numbers. Use of an Olszewski tube can help combat these problems with hypolimnetic withdrawal. Blooms may be observed in freshwater aquariums when fish are overfed and excess nutrients are not absorbed by plants. These are generally harmful for fish, and the situation can be corrected by changing the water in the tank and then reducing the amount of food given. Harmful algal blooms[edit] An algae bloom off the southern coast of Devon and Cornwall in England, in Satellite image of phytoplankton swirling around the Swedish island of Gotland in the Baltic Sea , in A harmful algal bloom HAB is an algal bloom that causes negative impacts to other organisms via production of natural toxins, mechanical damage to other organisms, or by other means. HABs are often associated with large-scale marine mortality events and have been associated with various types of shellfish poisonings. These organisms, referred to as phytoplankton or microalgae, form the base of the food web upon which nearly all other marine organisms depend. Harmful algal blooms have been observed to cause adverse effects to a wide variety of aquatic organisms, most notably marine mammals, sea turtles, seabirds and finfish. The impacts of HAB toxins on these groups can include harmful changes to their developmental, immunological, neurological, or reproductive capacities. The most conspicuous effects of HABs on marine wildlife are large-scale mortality events associated with toxin-producing blooms. For example, a mass mortality event of bottlenose dolphins occurred along the Florida panhandle in the spring of due to ingestion of contaminated menhaden with high levels of brevetoxin. Ingestion of such contaminated prey can affect respiratory capabilities, feeding behavior, and ultimately the reproductive condition of the population. Brevetoxin exposure, via inhalation of aerosolized toxins and ingestion of contaminated prey, can have clinical signs of increased lethargy and muscle weakness in loggerhead sea turtles causing these animals to wash ashore in a decreased metabolic state with increases of immune system responses upon blood analysis. The Gulf of Maine frequently experiences blooms of the dinoflagellate Alexandrium fundyense , an organism that produces saxitoxin , the neurotoxin responsible for paralytic shellfish poisoning. The well-known "Florida red tide" that occurs in the Gulf of Mexico is a HAB caused by Karenia brevis , another dinoflagellate which produces brevetoxin, the neurotoxin responsible for neurotoxic shellfish poisoning. California coastal waters also experience seasonal blooms of Pseudo-nitzschia , a diatom known to produce domoic acid , the neurotoxin responsible for amnesic shellfish poisoning. These blooms of organisms cause severe disruptions in fisheries of these waters as the toxins in the phytoplankton cause filter-feeding shellfish in affected waters to become poisonous for human consumption. Not all algal blooms are dense enough to cause water discolouration.

Chapter 5 : The Effects: Environment | Nutrient Pollution | US EPA

NIEHS research uses state-of-the-art science and technology to investigate the interplay between environmental exposures, human biology, genetics, and common diseases to help prevent disease and improve human health.

Chapter 6 : Algae Growth in Relation to Light Intensity

State of the Science Workshop on Differentiating Human and Non-human Fecal Sources and Identifying Research Needs for Beaches Impacted Primarily by Non-human Sources, SCCWRP, Pathogens and Algal Toxins of Concern to Public Health in Puget Sound Workshop, Seattle, WA,

Chapter 7 : Environment | College of Public Health | The Ohio State University

UNII-VKS19V6FQN; SAXITOXIN DIHYDROCHLORIDE Environmental Science Research. Volume The Water Environment-Algal Toxins and Health. Volume The Water.

Chapter 8 : Algal bloom - Wikipedia

Algal toxins are a group of toxic compounds produced by a range of photosynthetic freshwater and marine plankton. These toxins have the ability to cause sickness in animals and humans and in severe cases lead to death.

Chapter 9 : Saxitoxin dihydrochloride | C10H19Cl2N7O4 - PubChem

Harmful algal blooms are a major environmental problem in all 50 states. Red tides, blue-green algae, and cyanobacteria are examples of harmful algal blooms that can have severe impacts on human health, aquatic ecosystems, and the economy. Algal blooms can be toxic. Keep people and pets away from.