California Regional Water Quality Control Board
Colorado River Basin Region 7
SWAMP HABs Program

Assessment of Cyanobacteria and Cyanotoxin Occurrence In Water and Benthic Algal Mats at the Salton Sea

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Project

The California Regional Water Quality Control Board, Colorado River Basin, conducted a 12-month assessment of the occurrence of cyanobacteria and associated cyanotoxins. Under the Surface Water Ambient Monitoring Program's (SWAMP) Harmful Algal Blooms (HABs) program, cyanobacteria and cyanotoxins monitoring was conducted at the Salton Sea from September 2020 through August 2021. HABs have become increasingly problematic throughout the country, and at the Salton Sea, warm temperatures, abundant sunlight and an excess of nutrients provide highly suitable conditions for cyanobacteria to thrive and bloom. Cyanotoxins are known to be harmful or even fatal to both people and animals, and sudden blooms can produce high concentrations of these toxins. Thus, it is imperative to continually monitor the levels of these toxins in the interest of public health and the wide array of beneficial uses associated with the Salton Sea

Purpose

The purpose of this assessment was: (1) to identify the spatial distribution of cyanobacteria genera and associated toxins present in benthic algal mats along the shore of the Salton Sea; (2) to determine if any detectable changes in the cyanobacteria community composition have occurred compared to historical studies of the Salton Sea. This information is needed to understand the current distribution of cyanobacteriain algal mats their potential for cyanotoxin production, and the relative rate at which the cyanobacteria community composition is changing. These data will help inform the public of potential health hazards associated with harmful benthic algal mats at the Salton Sea.

Background

The Salton Sea is located in Southern California and covers parts of Riverside and Imperial Counties. Thesea is a hyper-saline, hyper-eutrophic, endorheic lake situated more than 230ft below mean sea level. The Salton Sea is approximately 15 miles in width and 35 miles in length at its longest reaches, with a maximumdepth between 43-51 feet. For more than 100 years, this artificially sustained sea has served as a receptaclefor municipal and agricultural wastewater inflows, however, water transfers and water conservation effortshave led to a significant reduction of those inflows, resulting in rapid shrinking of the Sea .

This shallow lake hosts multiple genera of cyanobacteria which inhabit the benthic algal mats that line much of the littoral zone. The mats overlie near-shore sediments and rigid substrates, thriving in areas where the photic zone extends to the sea floor, while significant wind events appear to damage the mats inshallow areas, as observed during the assessment.

Historical water quality monitoring of inflows to Salton Sea show an excessive level of nutrient loading due to runoff from nearly 500,000 acres of adjacent agricultural land. Harmful algal blooms are known to occur in response to acute increases in nutrient concentrations, such as the nitrogen and phosphorous loading from agriculture runoff. However, any attempt to divert these nutrient-rich inflows away from thesea to mitigate harmful algal blooms would result in further shrinkage of the sea. Moreover, attempts to introduce less inflow to the sea would almost certainly result in changes to the cyanobacteria community, since these inflows are much less saline than the sea, and they provide some degree of dilution. This couldpotentially increase harmful algal blooms in both frequency and magnitude by replacing the endemic cyanobacteria with genera capable of surpassing current toxin production.

Monitoring Design

Water, algal mat and algal scum grab samples were collected monthly for one year, taken from theshoreline of the Salton Sea at five monitoring sites (Figure 1):

1. Desert Shores
2. West Shores
3. Obsidian Butte
4. Bombay Beach
5. State Recreation Area

Figure 1: Map of Salton Sea Sampling Sites

Site selection was based upon frequency of public use, site accessibility and historical occurrences of cyanotoxins. There are limited public access points along the perimeter of the sea, and so the most frequently used access points were selected for this assessment. In addition, these sites were known to have detectable levels of cyanotoxins, as discovered during a previous monitoring effort conducted by the Regional Board in 2017-2018.

Samples for this assessment were collected in accordance with the Surface Water Ambient Monitoring Program (SWAMP) Standard Operating Procedures (SOP). Collected samples were shipped to Bend Genetics located in Sacramento, California, and analyzed using Enzyme Linked Immunosorbent Assays (ELISA). The dominant genera of cyanobacteria found in the samples was also identified by microscopy and documented.

Sample Collections

Salton Sea algal mat production is prolific, occupying the littoral zone along much of the sea's perimeter. Mats occur in different hues of greens, browns and yellows, varying in thickness up to 7mm, and coveringa range of substrates including sediments, gypsum crusts and even fine clay and silts, all of which make sample collections a challenge. Cross-sections of some mats display distinct stratified layers of colored 'bands', which are more visible in thicker mats. Microscopy of the mat material reveals a significant amountof sediment and detritus embedded within the mats, including decaying organic material, barnacle nauplii and *Corixid* body parts.

Figure 2: Cross Section of Benthic Sediment with Overlying Algal Mat

During collection of algal mats overlying sediments, the mat was at times very thin (<1.0mm), causing more sediment to be collected than algal sample. Soft bristle brushes were found to be incapable of liberating the algal material from the substrate, while a stiffer nylon brush removed both algal material andforeign material, including sediment. Various collection techniques and tools were employed throughout the assessment; however, none were successful in cleanly separating the mat from the underlying substrate. It should be noted that during the latter part of this assessment, the author developed a collection technique that minimizes the amount of sediment collected with the sample. A Standard Operating Procedure (SOP)incorporating that method is under development by the Colorado River Basin Regional Water Quality Control Board.

Removal of algal mat material from gypsum crusts was equally problematic, with some of the same issuesencountered. The gypsum crust is rigid and has many nooks and pits along its uneven surfaces, and it is also brittle. When attempting to separate the algal mat from the crust, bits of barnacle shells, sediment, crustand other foreign material were also unintentionally collected.

Temporal Changes in Cyanobacteria Community

Over the 12-month monitoring period, 100 water, sediment and surface scum samples were collected fromfive near-shore sites along the perimeter of the Salton Sea. From those samples, a total of (12) distinct cyanobacteria genera were identified by microscopy, with the most frequently observed genera in both water and algal mat samples being *Oscillatoria*, *Geitlerinema* and *Spirulina*. In examining this limited dataset, there doesn't appear to be any evidence of significant seasonal variation regarding cyanobacteria genera at the sea, but based upon historical observations, the cyanobacteria community within the Salton Sea has changed over a relatively short time.

Tiffany et al. (2007) mentions observations of *Oscillatoria, Geitlerinema* and *Lyngbya*, noting that cyanobacteria made up only a small percentage of the total phytoplankton in the sea at that time. They found that the occurrence of these filamentous cyanobacteria in open, mid-lake waters was rare, suggestingthe bacteria are restricted almost entirely to near-shore environs. Carpelan (1961) too found that microscopic filamentous cyanobacteria were far more abundant in benthic mats near shore that occasionally broke loose and floated to the surface. Our findings support these conclusions, since cyanotoxins were at times undetected in the water column near shore, while up to four cyanotoxins (*Anatoxin-a, Saxitoxin, Microcystin* and *Cylindrospermopsin*) were simultaneously detected in a single sample of benthic algal matcollected in the same vicinity.

Wood et al. (2002) describes ten distinct genera observed primarily in mat samples collected from the SaltonSea in 1999: *Oscillatoria, Spirulina, Arthrospira, Geitlerinema, Lyngbya, Leptolyngbya, Calothrix, Rivularia, Synechococcus, Synechocystis*. Of these ten genera, only four (*Geitlerinema, Lyngbya, Oscillatoria and Spirulina*) were observed in the samples we collected for our assessment (table 1). In spring of 2005, filamentous cyanobacteria (*Oscillatoria, Arthrospira* and *Geitlerinema*) were dominant in mid-lake phytoplankton, comprising 3-10% of total phytoplankton biomass (Anderson et al. 2007).

Although some previously observed genera also appeared in samples collected during this assessment, seven additional genera were observed which weren't reported in previous studies. These genera include *Kamptonema, Pseudanabaena, Trichocoleus, Wilmottia, Symploca, Microleus* and *Johanseninema (Table1)*.

During this assessment, diatoms co-dominated multiple samples, which was also observed by Tiffany et al.(2007). However, since this assessment focused on cyanobacteria, the taxonomy of diatoms is not within the purview of this assessment and thus was not established.

Table 1: Salton Sea Cyanobacteria Genera Observed From 1960 Through 2021

Genera	Study Year				
	1960 Carpelan., 1961	1999-2000 Carmichael., 2006	1999 Wood., 2002	2005-2006 Anderson et al., 2007	2021 Present Assessment
Oscillatoria	X	X	X	X	X
Spirulina	X		X		X
Geitlerinema		X	X	X	X
Lyngbya		X	X	X	X
Synechococcus		X	X	X	
Merismopedia		X		X	
Phormidium	X	X			
Synechocystis			X		
Leptolyngbya			X		
Calothrix			X		
Rivularia			X		
Arthrospira			X		
Hydrocoleum	X				
Calothrix	X				
Plectonema	X				
Pleurococcus	X				
Pleurocapsa	X				
Aphanothece		X			
Gloeocapsa		X			
**Kamptonema*					X
**Microleus*					X
**Johanseninema*					X
**Phormidium*					X
**Wilmottia*					X
**Pseudanabaena*					X
**Trichocoleus*					X
**Symploca*					X

* Genera not observed in previous assessments

Cyanotoxins

Cyanotoxins are a concern for public health given their potency and harmful effects on birds and mammals.The State Water Resources Control Board (SWRCB), in collaboration with the Office of EnvironmentalHealth Hazard Assessment (OEHHA), has established a set of tiered protocols for responding tooccurrences of planktonic Harmful Algal Blooms (HABs). These protocols include response trigger levelsfor detected cyanotoxin concentrations (figure 4) and signage intended to inform the public of the dangersof benthic HABs (Appendix B). Recently, signage and protocols have been developed specifically forbenthic algal mats and are available on the SWRCB website: (https://mywaterquality.ca.gov/habs/resources/habs_response.html).

A total of 100 samples were analyzed for cyanotoxins during the course of our assessment, specifically 50water samples, 39 benthic algal mat samples and 11 scum samples. These samples were subjected to ELISA testing for quantitative analysis of *Anatoxin-a, Saxitoxin, Cylindrospermopsin* and *Microcystins*.

Table 2: Occurrences of Cyanotoxins in Water, Scum and Algal Mat Samples

	Sample Type		
Cyanotoxin	Water (50 samples)	Mat (39 samples)	Scum (11 samples)
Anatoxin-a	2 (4%)	22 (56%)	4 (36%)
Saxitoxin	41 (82%)	15 (38%)	4 (36%)
Cylindrospermopsin	40 (80%)	23 (58%)	5 (45%)
Microcystin	8 (16%)	17 (44%)	6 (54%)

None of the 50 water samples collected and analyzed exceeded the caution-level threshold for *Cylindrospermopsin* or *Microcystin*. Only two water samples had detectable concentrations of *Anatoxin-a*,which warranted a caution-level response, but *Anatoxin-a* was more frequently detected in algal mats, with 22 of the 39 mat samples containing *Anatoxin-a*. Both *Saxitoxin* and *Cylindrospermopsin* were detected more often in water than in benthic mats. Of the 39 benthic mat samples collected, 28 samples (72%) had detectable levels of cyanotoxins, triggering a caution-level response.

Microcystin

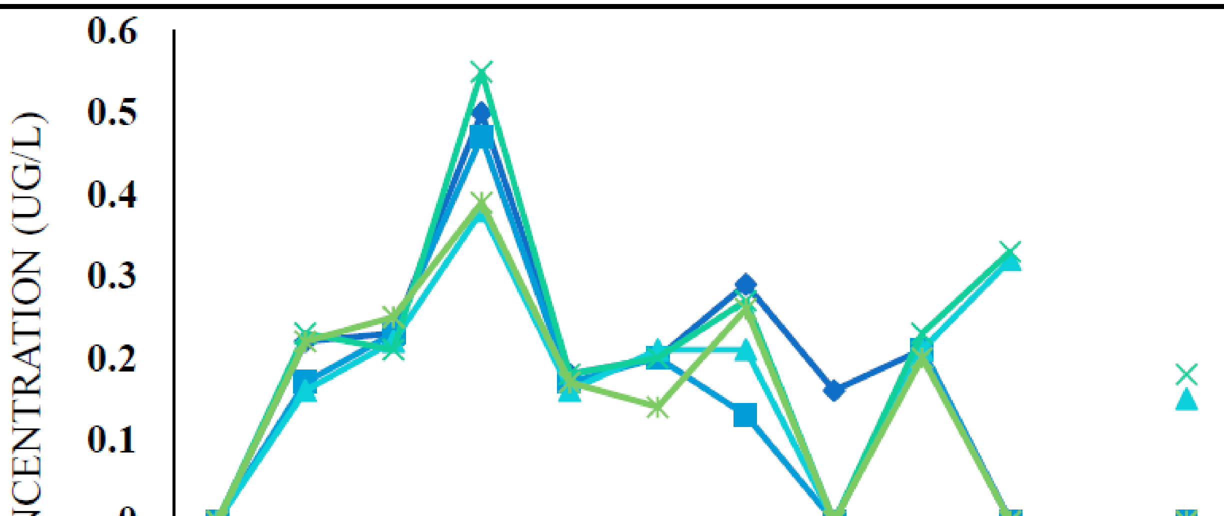
Of the combined 39 mat and 50 water samples analyzed, only 25 of the 89 samples (28%) contained detectable levels of *Microcystin*. To compare with an earlier study conducted from 1999-2000, 247 water and sediment samples were collected from the Salton Sea and subjected to ELISA screening, with 85% ofthe samples containing detectable levels of *Microcystin* (Carmichael and Li, 2006). The author of the studyattributes the *Microcystin* toxin production to both *Oscillatoria* and picoplanktonic *Synechococcus*, whichwere the two dominant genera identified during that study. While this assessment detected *Microcystin* toxin concentrations in multiple samples, *Synechococcus* was not present. Some strains of *Synechococcus* are known to adapt to saline conditions by utilizing organic osmoregulatory solutes to expel excess inorganic ions (Mackay et. al, 1984), but it is unknown whether the absence of *Synechococcus* at the sea is due to the rapid increase in salinity. *Microcystins* did not appear in water samples until January, and detections only continued briefly through January and February. Microcystin detections in benthic mats were more frequent, absent only during the warmer summer months.

Anatoxin-a

Due to its toxic nature and potency, any detection of *Anatoxin-a* in water or algal mat samples triggers a caution-level response by the Regional Water Quality Control Board. *Anatoxin-a* was seldom found in thewater column, with only two detections over the 12-month assessment. In benthic algal mats, however, *Anatoxin-a* was present in 22 of the 39 (56%) collected samples. The highest detected concentration of Anatoxin-a (4.7 µg/L) was found in benthic mats collected in November 2020 from the Desert Shores site.

Cylindrospermopsin

The caution-level threshold for *Cylindrospermopsin* (1.0 µg/L) was never exceeded for water samples, eventhough *Cylindrospermopsin* was detected in 40 of 50 water samples. Benthic mat sample detections of *Cylindrospermopsin* numbered 23 out of 39, which all translated to caution-level threshold exceedances. The *Cylindrospermopsin* concentrations for water were relatively consistent when compared across all fivemonitoring sites (figure 3).



		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
SRA	0	0.22	0.23	0.5	0.18	0.2	0.29	0.16	0.21	0		0
BB	0	0.17	0.23	0.47	0.17	0.2	0.13	0	0.21	0		0
OB	0	0.16	0.22	0.38	0.16	0.21	0.21	0	0.21	0.32		0.15
WS	0	0.23	0.21	0.55	0.18	0.2	0.27	0	0.23	0.33		0.18
DS	0	0.22	0.25	0.39	0.17	0.14	0.26	0	0.2	0		0

Figure 3: Cylindrospermopsin Concentrations in Water at all Monitoring Sites

Public Health and the Salton Sea

Although detected cyanotoxin concentrations in our samples were generally low, the danger of cyanotoxinsis still present in the sea and should not be under-estimated. On April 5, 2021, a dog owner visiting SaltonSea witnessed her dog drinking from the sea. The dog's owner stated that when she approached her dog inthe shallow water, she saw a "brown coating on the bottom" that greatly concerned her. Almost immediately, the animal began to exhibit multiple symptoms indicative of cyanotoxin exposure. The dog was rushed to a veterinarian and died two days later; the cause of death being attributed to cyanotoxin exposure. The 'brown coating' the owner described is likely the extensive algal mat that covers the sediments and gypsum crust in that area. The site where this incident occurred was also one of the monitoring sites designated for this assessment, and so previous toxin data was available. A report of the incident is on file with the Office of Health Hazard Assessment (OEHHA) (Appendix C).

Currently, the SWRCB does not have established thresholds for *Saxitoxin* in water. Caution level thresholds for benthic algal mats are more stringent than for water, such that any detectable cyanotoxin concentration in benthic mats automatically triggers a caution-level response. Water samples collected from the incident site one month before the incident showed both *Cylindrospermopsin* and *Saxitoxin* at 0.29 µg/L and 0.05 µg/L, resp. A benthic algal mat sample collected at the same time showed a 0.21 µg/L concentration of *Cylindrospermopsin*. A subsequent water sample collected on April 12, 2021 (about one week after the incident) showed the presence of *Pseudanabaena* and a 0.16 µg/L concentration of *Cylindrospermopsin*, which is well below the 1.0 µg/L threshold. However, it's important to note that these results may not be representative of the conditions that existed at the time of the incident, since phytoplankton dynamics at thesea can shift rapidly, with cyanobacterial blooms changing daily.

Trigger Levels For Human and Animal Health				
Criteria*	No Advisory [a]	Caution (TIER 1)	Warning (TIER 2)	Danger (TIER 3)
Total Microcystins [b]	**< 0.8** µg/L	**0.8** µg/L	**6** µg/L	**20** µg/L
Anatoxin-a	Non-detect [c]	Detected [c]	**20** µg/L	**90** µg/L
Cylindrospermopsin	**< 1** µg/L	**1** µg/L	**4** µg/L	**17** µg/L

Figure 4: SWRCB Cyanotoxin Trigger Levels

Under the recommendation of the Colorado River Basin Water Quality Control Board, public health advisory signage posted at Salton Sea was temporarily changed by the State Park Service from a "caution"level to a "warning" level, even though detected cyanotoxin concentrations were well below the warning trigger-level. Since much of the sea's shoreline is covered in benthic algal mats, it's virtually impossible for recreators to avoid them. Moreover, the benthic mats often break apart, causing pieces of mat and scumto float to the surface where they can be ingested by swimmers or pets. Algal scum and mats can be very attractive to dogs, and these detached algal pieces can potentially contain very high concentrations of cyanotoxins, even when those toxins are not detected in water. The signage has since been changed back tothe "caution" level as of December 2021.

Table 3: Cyanobacteria Genera Occurrence in Water Samples

Genera found in water	State Rec. Area	Bombay Beach	Obsidian Butte	West Shores	Desert Shores
Spirulina	5	3	7	8	9
Geitlerinema	1	1	5	5	5
Oscillatoria	1	4	2	2	1
Kamptonema	1	-	-	2	-
Phormidium	-	-	1	-	-
Lyngbya	-	-	1	-	-
Pseudanabaena	1	-	-	-	-

Table 4: Cyanobacteria Genera Occurrence in Benthic Algal Mat Samples

Genera Found in Benthic Algal Mats	State Rec. Area	Bombay Beach	Obsidian Butte	West Shores	Desert Shores
Spirulina	5	3	2	7	8
Geitlerinema	2	4	3	7	7
Oscillatoria	7	7	1	6	5
Kamptonema	3	5	1	-	2
Phormidium	1	2	-	2	2
Pseudanabaena	-	1	-	-	-
Trichocoleus	-	-	-	-	1
Wilmottia	1	1	-	-	-
Johanseninema	-	1	-	-	1
Symploca	1	-	-	-	-
Microcoleus	-	-	-	1	-

Discussion

From September 2020 to August 2021, at least (12) genera of cyanobacteria were detected in the littoral zone of the Salton Sea, contained within the benthic algal mats that lie along much of the shoreline. These cyanobacteria are producing detectable levels of *Anatoxin-a, Saxitoxin, Cylindrospermopsin* and *Microcystin* throughout the year, triggering public health advisories at the cautionary and warning levels (Figure 4). One confirmed animal fatality due to ingestion of cyanotoxins at Salton Sea occurred at one of the designated monitoring sites during this assessment.

The marine picoplanktonic *Synechococcus,* which was once considered co-dominant in Salton Sea phytoplankton, no longer appears to be present in the sea. Benthic algal mats are well established along much of the shore, making it virtually impossible for recreators to avoid contact with the mats. High windscreate churning water that damages the mats, causing pieces to break off and float to the surface. These matpieces, along with floating surface scum, were observed accumulating en masse at the shore during wind events. This presents a significant health risk, not only because algal mats and algal scum typically containhigher concentrations of cyanotoxins than other matrices, but also because they're accumulating at the shorewhere people and pets are likely to be exposed.

As the sea continues to experience increased salinity and other water chemistry changes, the cyanobacteriacommunity can be expected to change as well. Inflows to the sea are predominantly composed of agricultural drainage and municipal wastewater that is high in nutrients. The implementation of TMDLs and other regulatory actions may not be effective in avoiding harmful algal blooms in the future, since cyanobacteria and other algae are known to thrive even in lower nutrient concentrations. Efforts to effectively manage cyanobacteria at the sea will likely require an intense, multi-faceted approach that mayinclude a nutrient removal mechanism (such as filtration, ion exchange or similar process), large-scale watercirculation and water tinting.

Limitations

This report is based on a very limited dataset which makes it difficult, if not impossible, to offer any conclusions in terms of temporal trends. Moreover, our assessment targeted water, scum and benthic algalmats at the shore, yet these matrices were not always present at some sites and could not be collected. In some instances, only water could be collected, while scum was at times the only matrix that was present oraccessible. The effect of wind on the mats was significant (i.e., damaging algal mats or covering benthic mats in thick layers of organic matter and sediment) and prevented the collection of viable mats in some instances. Rainstorms made sample collection impossible at some sites due to extremely muddy conditionsthat reached depths in excess of 35-inches. Sample collection methods and locations used in this assessmentdiffered from that of the previous studies mentioned, which could influence the differences in cyanobacteria genera observed.

References

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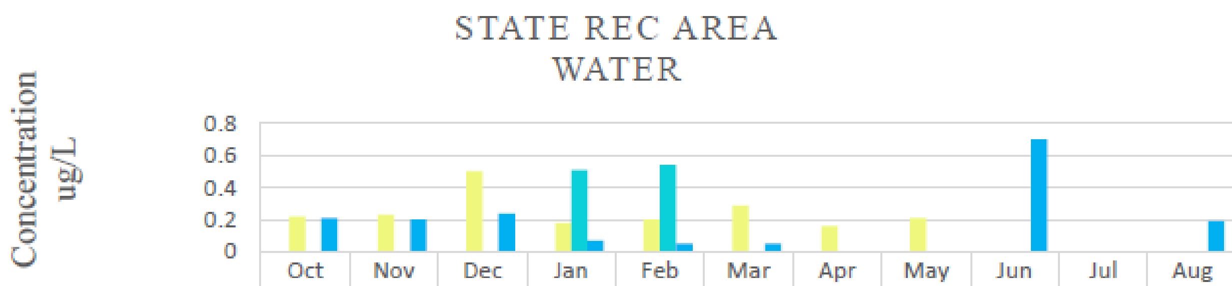
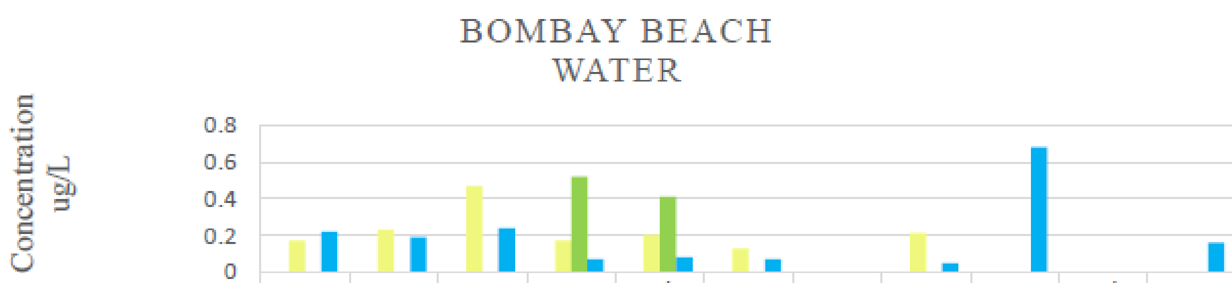
Appendix A: *Cyanotoxin Concentrations in Water and Benthic Algal Mats*

(Missing values represent samples that could not be collected)



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	0	0	0	0	0	0	0	0	0		0
cylindrospermopsin	0.22	0.23	0.5	0.18	0.2	0.29	0.16	0.21	0		0
microcystin	0	0	0	0.51	0.54	0	0	0	0		0
saxitoxin	0.21	0.2	0.24	0.07	0.05	0.05	0	0	0.7		0.19



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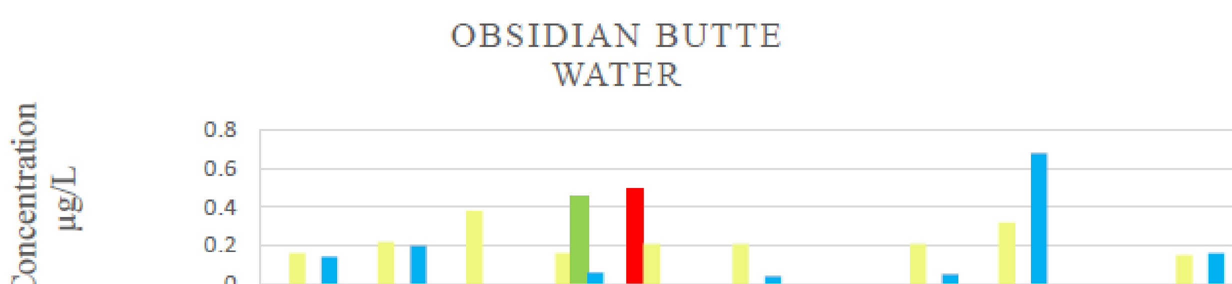
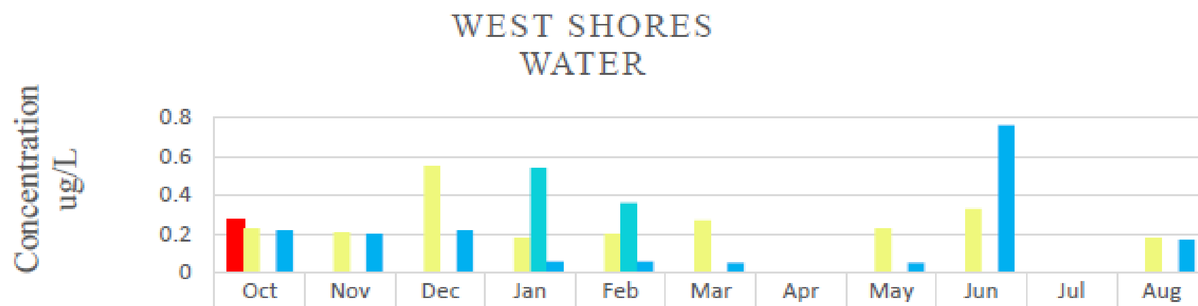
anatoxin-a	0	0	0	0	0	0	0	0	0		0
cylindrospermopsin	0.17	0.23	0.47	0.17	0.2	0.13	0	0.21	0		0
microcystin	0	0	0	0.52	0.41	0	0	0	0		0
saxitoxin	0.22	0.19	0.24	0.07	0.08	0.07	0	0.05	0.68		0.16



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	0	0	0	0	0.5	0	0	0	0		0
cylindrospermopsin	0.16	0.22	0.38	0.16	0.21	0.21	0	0.21	0.32		0.15
microcystin	0	0	0	0.46	0	0	0	0	0		0
saxitoxin	0.14	0.2	0	0.06	0	0.04	0	0.05	0.68		0.16



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
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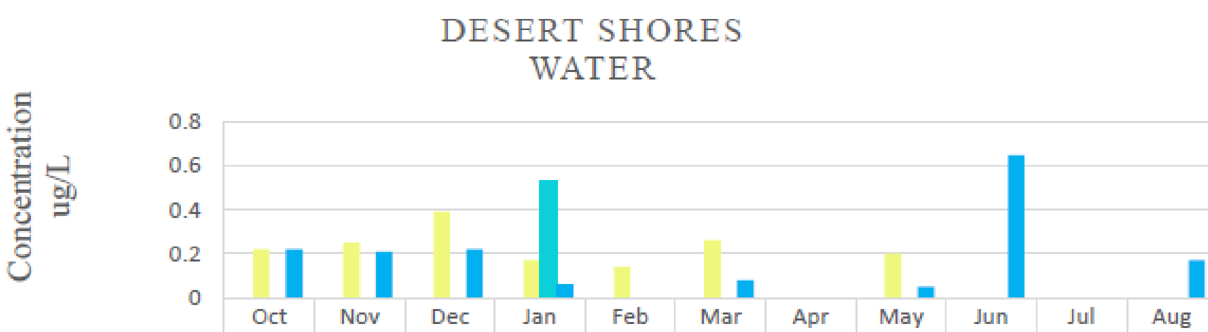
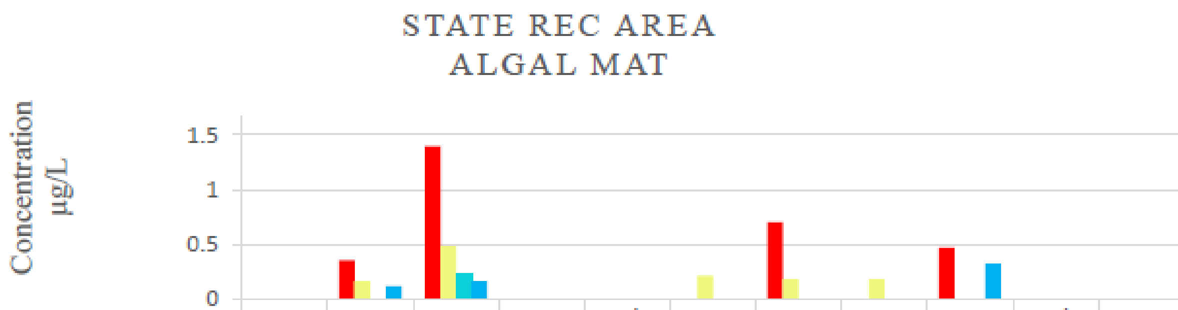
cylindrospermopsin	0.23	0.21	0.55	0.18	0.2	0.27	0	0.23	0.33		0.18
microcystin	0	0	0	0.54	0.36	0	0	0	0		0
saxitoxin	0.22	0.2	0.22	0.06	0.06	0.05	0	0.05	0.76		0.17



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	0	0	0	0	0	0	0	0	0		0
cylindrospermopsin	0.22	0.25	0.39	0.17	0.14	0.26	0	0.2	0		0
microcystin	0	0	0	0.53	0	0	0	0	0		0
saxitoxin	0.22	0.21	0.22	0.06	0	0.08	0	0.05	0.65		0.17



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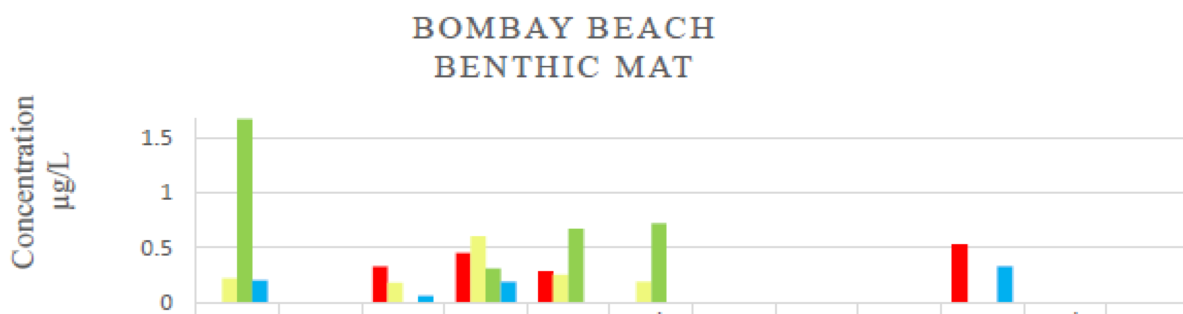
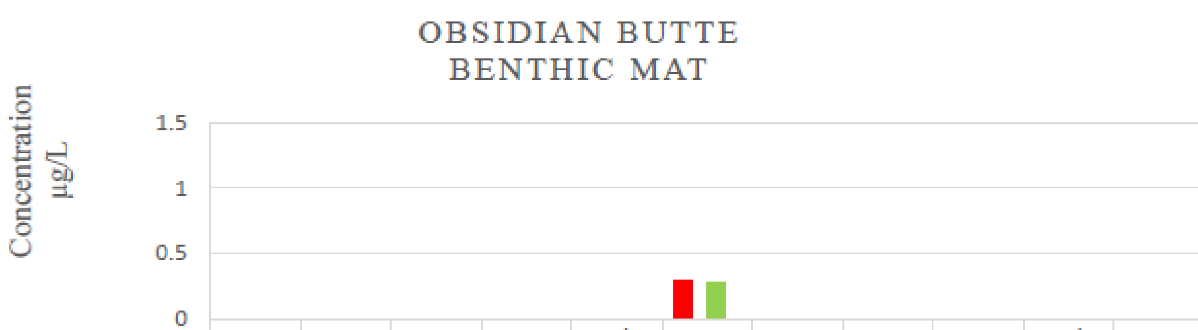
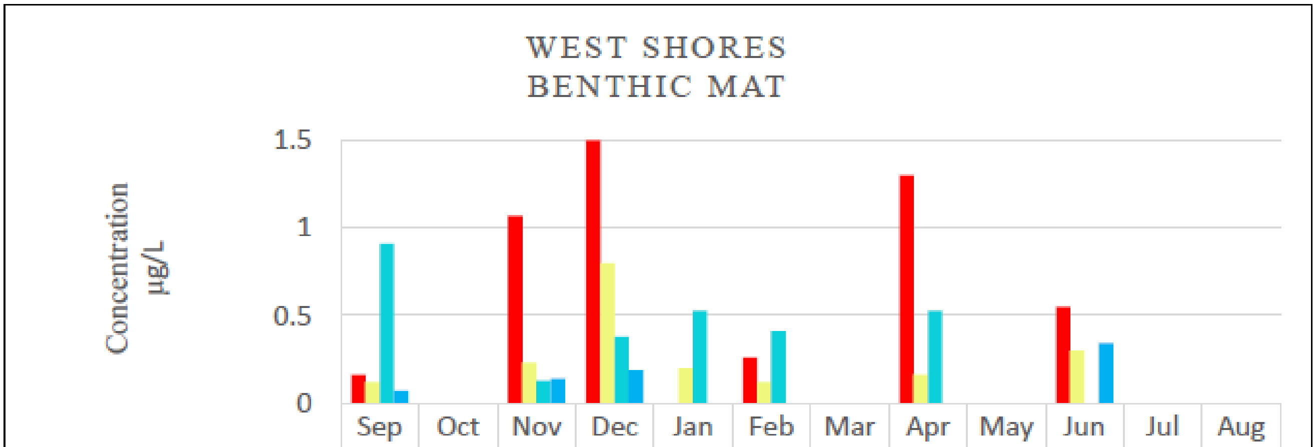
cylindrospermopsin 0.25		0.16	0.48	0		0.21	0.18	0.18	0		
microcystin 4.99		0	0.22	0		0	0	0	0		
saxitoxin 0.18		0.11	0.16	0		0	0	0	0.32		



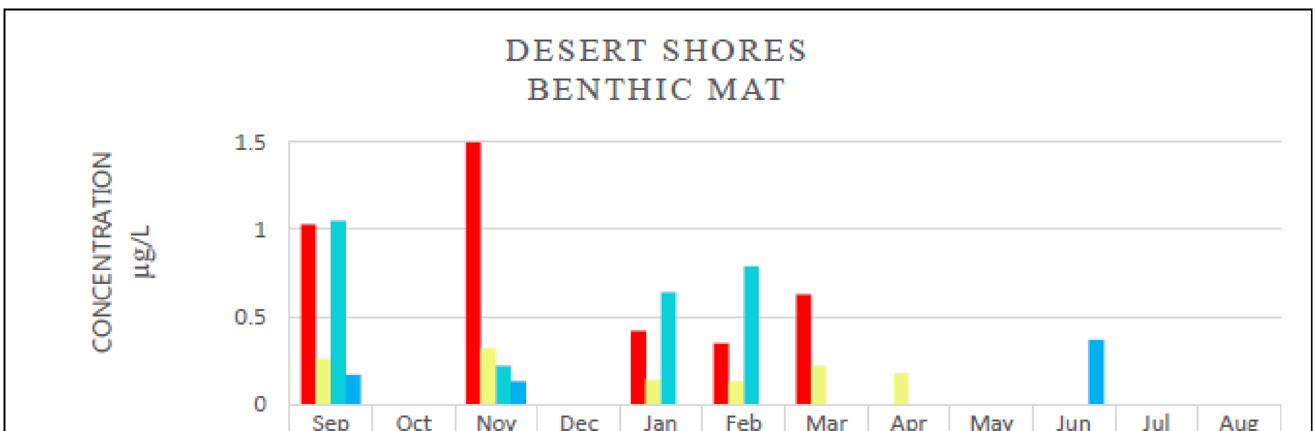
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	0		0.33	0.45	0.28	0	0	0	0	0.53		0
cylindrospermopsin	0.22		0.18	0.6	0.25	0.19	0	0	0	0		0
microcystin	1.67		0	0.31	0.67	0.72	0	0	0	0		0
saxitoxin	0.2		0.06	0.19	0	0	0	0	0	0.33		0



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a						0.3					0
cylindrospermopsin						0					0
microcystin						0.28					0
saxitoxin						0					0



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	0.16		1.07	3.02	0	0.26	0	1.3	0	0.55		0
cylindrospermopsin	0.12		0.23	0.8	0.2	0.12	0	0.16	0	0.3		0
microcystin	0.91		0.13	0.38	0.53	0.41	0	0.53	0	0		0
saxitoxin	0.07		0.14	0.19	0	0	0	0	0	0.34		0



	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
anatoxin-a	1.03		4.7		0.42	0.35	0.63	0	0	0		0
cylindrospermopsin	0.26		0.32		0.14	0.13	0.22	0.18	0	0		0
microcystin	1.05		0.22		0.64	0.79	0	0	0	0		0
saxitoxin	0.17		0.13		0	0	0	0	0	0.37		0

Appendix B: *Signage for Benthic Algal Mat Notification*

Appendix C: *Report of Dog Mortality at Salton Sea*

Reset Form

One Health Harmful Algal Bloom System (OHHABS)

Environmental Form

Form Approved
OMB No. 0920-1105
Expires 03/31/2022

CDC REPORT ID	CDC FORM ID	STATE REPORT ID	DATE CREATED
		2021_2655	04/23/2021

GENERAL INFORMATION

Dates (MM/DD/YYYY)

Date bloom was first observed 01/21/2021

Date of bloom notification to Local, Territorial, Tribal, or State Health Authorities 01/21/2021

If no bloom date is available, select and explain in Remarks.

1-Foodborne intoxication, 2-Other evidence of harmful algal toxicity

Date Remarks: bloom continuing from 2020, used date of first monitoring in 2021

Geographic Description (For foodborne intoxication, report where food was caught/harvested)

Location

State/Jurisdiction California — Count(ies) Riverside

Did an algal bloom impact water quality in any other states/jurisdictions?

☐ Yes ☒ No ☐ Unknown ☐ Not applicable

If Yes, what other state(s) were affected?

Official name of water body Salton Sea — Common name of water body Salton Sea

Specific location name Salton Sea State Rec. Area — Nearest city/town La Quinta

Location Coordinates

Coordinate format: ☐ Degrees Minutes Seconds (DD MM SS) ☒ Decimal Degrees (DDD.DDDD)

Latitude 33.505 — Longitude -115.9

Hydrologic unit code (*e.g., 04-Great Lakes*) Region 18 - California — http://water.usgs.gov/GIS/huc.html

Water Body Characteristics

Water type (*e.g., Lake, Ocean*) Other — Water salinity Salt

What is the water body, or if applicable, the area of the water body where the bloom was located, used for? (*check all that apply*)

☒ Agriculture ☐ Aquaculture ☐ Industrial/Occupational
☐ Public drinking water system ☐ Raw/Non-potable water use (*e.g., lawn care*) ☒ Recreation
☐ Other (*describe in Remarks*) ☐ None ☐ Unknown

Geographic Description Remarks

Inland sea with salinity higher than natural sea water.
https://public.tableau.com/shared/MSCHNG27Q?:display_count=y&:origin=viz_share_link&:embed=y
Other locations at Salton Sea (Desert Shores, West Shores, Obsidian Butte, Bombay Bay) routinely monitored

CDC 52.16A (E), Revised April 2016, CDC Adobe Acrobat 11.0, S508 Electronic Version, May 2016
UPDATED 20 Apr 2016 — Page 1 of 4

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One Health Harmful Algal Bloom System (OHHABS)

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BLOOM DESCRIPTION

Health Advisories/Warnings

Advisory or warning type	Response (i.e., Yes/No/ Unknown/ Not Applicable)	Issuing agency (e.g., State Park, Health Department)	Criteria/Reason(s) for issue (e.g., Bloom observed, Toxin detected)	Start date (MM/DD/YYYY)	End date (MM/DD/YYYY)
Health advisory	Yes	Water Board recommended based on voluntary guidanc	bloom and toxin	02/01/2021	
No contact warning					
Water body closure (recreational activity)					
Water body closure (fish/shellfish)					
Other					

Observational Data

Date documented (MM/DD/YYYY)	Documented by (e.g., General public, Park ranger)	Scum or algal matter observed? (i.e., Yes/No/ Unknown)	Water color (e.g., Blue-green, Brown)	Water clarity (e.g., Clear, Muddy)	Water odors (i.e. Yes/No/ Unknown) *(If Yes, describe in Remarks)*	Water flow (e.g., Stagnant, Moving, Unknown)	Tidal conditions (e.g., High tide, Low tide)
01/21/2021	Regional Water Board staff	No					
02/18/2021	Regional Water Board staff	Yes					
03/16/2021	Regional Water Board staff	Yes					
04/12/2021	Regional Water Board staff	Yes					

LABORATORY TESTING

Algae, Algal Toxins, or Components Testing

Which of the following was tested for algae, algal toxins, or components? *(check all that apply)*

- [ ] Air
- [x] Algae
- [ ] Finished drinking water
- [ ] Food
- [x] Raw/Ambient water
- [ ] No testing
- [ ] Other
- [ ] Unknown

If testing was conducted,

1) Why was it tested? *(check all that apply)*

- [ ] Fish illness/kill*
- [x] Animal health event response*
- [ ] Citizen complaint
- [ ] Human health event response*
- [x] Monitoring
- [ ] Odor
- [ ] Other
- [ ] Unknown

Please include a form for the corresponding human or animal case(s)

2) If water was tested, was it tested for any of the following? *(check all that apply)*

- [x] Algae
- [x] Algal toxins
- [ ] Chlorophyll
- [ ] Copper sulfate
- [ ] Enterococci
- [ ] Fecal coliforms
- [ ] Other
- [ ] Unknown

Laboratory Results (Please report information that characterizes algal testing results in environmental or food samples—more extensive results may be attached to this report)

Laboratory Result Number	1	2	3	4	5
Classification (e.g., Cyanobacteria, Toxin)	Toxin	Toxin	Toxin	Toxin	
Genus or toxin (e.g., *Microcystis*)	Cylindrospermopsin	Cylindrospermopsin	Cylindrospermopsin	Saxitoxin	
Species (e.g., *aeruginosa*)					
Sub-species (e.g., f. scripta)					
Detected in? (e.g., Water, Food)	water	mat	water	water	
Sample description (e.g., lake water sample)	water sample	benthic mat sample	water sample	water sample	
Concentration (e.g., 20)	0.16	0.21	0.29	0.05	
Unit (e.g., ppm)	ppb (µg/L)	ppb (µg/L)	ppb (µg/L)	ppb (µg/L)	
Test type (e.g., ELISA)	Biological Assay (ELISA, PPIA, neurochemical, PCR, DNA or RNA probe)	Biological Assay (ELISA, PPIA, neurochemical, PCR, DNA or RNA probe)	Biological Assay (ELISA, PPIA, neurochemical, PCR, DNA or RNA probe)	Biological Assay (ELISA, PPIA, neurochemical, PCR, DNA or RNA probe)	
Sample collection date (MM/DD/YYYY)	04/12/2021	03/08/2021	03/08/2021	03/08/2021	
Sample collection time (##:##)	1:22 ☐ AM ☒ PM	1:28 ☐ AM ☒ PM	1:23 ☐ AM ☒ PM	1:23 ☐ AM ☒ PM	☐ AM ☐ PM

Laboratory Testing Remarks

4/12/21: A single water sample was collected for analysis for cyanotoxins. Cylindrospermopsin was detected at a concentration of 0.16 ug/L; ATX, MC/NOD, SAX all non-detect. Pseudoanabaena at low abundance in microscopy of water sample.
4/5/2021: Report of a dog fatality at the Salton Sea State Recreation Area. Owner reported that the dog had ingested water at the shore and thereafter exhibited a number of symptoms indicative of cyanotoxin exposure.The dog was taken to an emergency animal hospital for treatment, but sadly the animal died two days later on April 7, 2021.
3/16/2021: Water and algal mat samples were collected on 3/8/21. Water sample showed low detections of saxitoxin and cylindrospermopsin. Algal mat sample showed low concentration of cylindrospermopsin. ATX and MC/NOD non-detect for both samples, saxitoxin non-detect for mat sample. Water sample had no cyanobacteria identified by microscopy. Symploca sp (moderate), Kamptonema sp. (low) and Oscillatoria sp (low) identified in mat sample.
2/18/2021: Water and scum samples collected. Water samples results detected 0.2 ug/L CYL, 0.54 ug/L MC/NOD, 0.05 ug/L SAX and eukaryotic algae. Scum sample detected 1.4 ug/L MC/NOD, 0.4 ug/L CYL, 0.24 ug/L SAX and moderately low amount of Kamptonema sp.. Recommend posting caution sign.
1/21/21: Water samples collected. Water sample results detected low concentrations of cyanotoxins. Caution advisory not advised based on results.

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LINKS TO OTHER SYSTEMS

Links To Other Data Systems Containing Information About This Report (Use the table below to link this report to other data systems that contain related information)

If a National Outbreak Reporting System (NORS) report was created to summarize a human outbreak associated with this OHHABS report, please enter the **NORS State ID** in the **System Report ID Number** field.

System type (e.g., Federal)	**System name** (e.g., NORS)	**System report ID number** (e.g., NORS State ID)	**Brief description of linked information** (e.g., Ciguatera outbreak)

SUPPLEMENTAL INFORMATION

General Remarks (Please include or attach any information that was not captured in this form)

General Remarks Return

https://public.tableau.com/shared/MSCHNG27Q?:display_count=y&:origin=viz_share_link&:embed=y
Other locations at Salton Sea (Desert Shores, West Shores, Obsidian Butte, Bombay Bay) routinely monitored with multiple benthic cyanobacterial types and multiple cyanotoxins detected.

AUTHOR AND AGENCY INFORMATION

Form Author: Beckye Stanton

Report Author:

Reporting Site Name:

Agency Name:

Agency Contact Name:

Agency Contact Title:

Agency Contact Phone:

Agency Contact Fax:

Agency Contact Email:

Print Form Save Form

Reset Form

One Health Harmful Algal Bloom System (OHHABS)

Environmental Form

Form Approved
OMB No. 0920-1105
Expires 03/31/2022

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- [x] No
- [ ] Unknown
- [ ] Not applicable

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Common name of water body Salton Sea

Specific location name Salton Sea State Rec. Area

Nearest city/town La Quinta

Location Coordinates

Coordinate format:
- [ ] Degrees Minutes Seconds (DD MM SS)
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http://water.usgs.gov/GIS/huc.html

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Water type *(e.g., Lake, Ocean)* Other

Water salinity Salt

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- [ ] Aquaculture
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Geographic Description Remarks

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https://public.tableau.com/shared/MSCHNG27Q?:display_count=y&:origin=viz_share_link&:embed=y
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