Jim Suty, President
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March 14, 2018

By Email

Board Members
SLO County Air Pollution Control District
3433 Roberto Court
San Luis Obispo, CA 93401

Re: Friends of Oceano Dunes Demands answers to why the APCD & APCO has withheld information and misled the State of California, the general public and other agencies.

Attachments: a) Friends of Oceano Dunes 2008 letter to the APCD
b) Determination of Airborne Crystalline Silica (Quartz) Exposure
c) Marine Contributions to Aerosol Particulates in a Coastal Environment

Dear District Board Members:

This letter is being submitted by Friends of Oceano Dunes, Inc. ("Friends"), a California not-for-profit corporation representing users of Oceano Dunes State Vehicle Recreational Area ("ODSVRA"). Friends is concerned about the Air Pollution Control District (APCD) and the Air Pollution Control Officer (APCO) withholding critical information and misleading the State of California, other agencies and the general public. Friends has raised concerns about the APCD not being transparent with data in the past, please reference the attached letter from 2008 (attachment a).

Over the past decade, the APCD and the APCO have deliberately made unsupported allegations regarding crystalline silica coming from the ODSVRA. We can make available letters, emails, news articles and public statements regarding the APCD promoting harmful silica coming from the ODSVRA when there is no supporting evidence.

This careless act of misinforming the public has scared local citizens into thinking the ODSVRA is creating this silica dust (reference articles below). These scared residents have acted out and perpetuated this falsehood that the camping and off road recreation at the ODSVRA is creating a situation where crystalline silica (Quartz) is then blown in land to their homes.

Friends of Oceano Dunes is a 501(c)(3) California Not-for-Profit Public Benefit Corporation, comprised of over 28,000 supporters. We represent, environmentalists, equestrians, campers, fishermen, families and off-road enthusiasts who enjoy the benefits of Public Access through Responsible Recreation at the Oceano Dunes State Vehicular Recreation Area (ODSVRA). We want to maintain Access For All!

Nipomo Mesa's problem isn't sand. It's silica

January 15, 2018 12:33 PM

The letter in the Dec. 18 Trib from David Hamilton ("News flash: Dunes will keep blowing sand into Nipomo Mesa,") about the dunes dust cannot go unanswered. It is yet another example of folks forming an opinion without information.

Those of us who are fighting for air that is not hazardous to our health are not trying to close the OHV park. Something as simple as planting vegetation in the most emissive areas is all it will take. The park can continue to operate and we can be alleviated from air pollution. They are not mutually exclusive.

Second, the problem is not SAND. It is silica dust. Sand and dunes exist along the entire coast of California, yet we are the only coastal area with hazardous silica dust. I know because twice over the last seven years we have contacted every Air Pollution Control District on the coast, and not one suffers particulate pollution from silica dust. And we are, of course, the only area with an OHV on the beach.

http://www.sanluisobispo.com/opinion/letters-to-the-editor/article194760449.html

Air quality on the Nipomo Mesa: The rest of the 'dust rule' story

BY ARLENE VERSAW

Think about it: Some years, 99 days a year, Mesa residents are subjected to hazardous silica dust that truly threatens human health. Even in a relatively "good year" like 2015, state standards for particulate matter were exceeded 62 days. And that is not the whole story, because particulate matter standards are based on a 24-hour average. At night, the wind generally does not blow. What we know for sure is that on days where state standards are *not* violated, during the peak windy parts of the day when most people would like to be outside (10 a.m. to 3 p.m.), pollution levels can be significantly above safe levels.

http://www.sanluisobispo.com/opinion/letters-to-the-editor/article67652377.html

The APCD completed studies in 2017 on several data samples collected over the April, May & June time frame, yet these studies were never made public. California State Parks then performed their own study and published a report in December 2017 (reference attachment b) which also includes copies of the APCD report. This report states: "Analytical results (attached) indicate none of the samples obtained by this investigation exceeded the current occupational health standard for total dust, respirable dust or quartz. **Crystalline silica (quartz) results were below the detection limit** for the analytical technique applied and volume of the air filtered for each sample" (emphasis added).

APCD & APCO, combined with scared local citizens, have created a HUGE falsehood and then used that to influence California State Parks, Air Research Board and Coastal Commission to further close areas of the ODSVRA for studies and permanent closure.

APCD & APCO further misled the State of California, other agencies and the general public regarding a claim in the Phase II study which incorrectly concluded that "The airborne particulate matter predominantly impacting the region on high episode days does not originate from an offshore source" (reference results from Chapter 6 below).

6.1. MAJOR FINDINGS

The following discussion presents the major findings and conclusions reached in this study, including brief summaries of supporting data from both the Phase 1 and Phase 2 studies.

1) **The airborne particulate matter predominantly impacting the region on high episode days does not originate from an offshore source.**
   - There are numerous particulate monitors located along the coast of California, including at Morro Bay and Grover Beach. None of the measurements at these sites show high PM concentrations during high onshore wind speed conditions, such as those seen on the Nipomo Mesa.
   - Grover Beach PM_{10} data shows a negative correlation to high winds. The only elevated PM_{10} readings at this site are associated with calm wind periods, likely the result of localized sea salt episodes typical of coastal locations. Further, these calm periods do not correlate to the periods of high PM seen on the Mesa. (See Section 3.1, Figure 3.6)
   - Elemental analysis of drum samples from Grover Beach showed high levels of chloride, a tracer for sea salt, and low levels of silica, a tracer for sand and soil. (See Section 5.3.3, Figure 5.13)

2) **A localized source of wind blown particulate is present in the Oceano area near Pier Avenue and may be impacting nearby residential neighborhoods.**

Chapter 6 – Summary and Conclusions *Page 6-1*

http://slocleanair.org/images/cms/upload/files/pdf/PM2-final_report.pdf

A study released today, "Marine Contributions to Aerosol Particulates in a Coastal Environment." This document was prepared by Dr. Brian Palenik of the Scripps Institution of Oceanography at UC San Diego (Scripps) as part of his investigation of particulates found on ocean-facing structures at the Oceano Dunes State Vehicular Recreation Area (Oceano Dunes)."

The California Geological Survey (CGS) cover letter also states: "Dr. Brian Palenik, professor of marine biology at Scripps, has examined these interactions. **He was intrigued by the aforementioned grit at Oceano Dunes and so designed a study that examined the biological signatures in seawater offshore from Oceano Dunes and that of the very fine grit material (less than 10 microns in diameter) collected from a variety of media, including filter tapes from EBAM air samplers deployed in the sand dunes.** Samples were collected in 2014, 2015, and 2016 and examined for the presence of marine prokaryotes (bacteria) and marine eukaryotes, such as phytoplankton diatoms, using DNA sequence analysis." Emphasis added.

The CGS cover letter also states: "The findings from this work have bearing on the ongoing efforts to mitigate airborne PM10 detected in Nipomo Mesa (Mesa), which is approximately two miles downwind from Oceano Dunes. At present, all mitigation efforts are focused on the reduction of saltation-derived dust emanating from locations within the 1500 acre off-highway vehicle (OHV) riding area of Oceano Dunes. Additionally, PM10 air dispersion modeling undertaken collaboratively with the California Air Resources Board and the San Luis Obispo County Air Pollution Control District considers saltation-derived dust from the OHV riding area of Oceano Dunes as the sole source of PM10 ultimately detected on the Mesa. As demonstrated by the Scripps investigation, **<u>the sourcing of airborne PM10 detected in this coastal setting is more complex, a function of several phenomena that occur on land, the ocean, and in the air. An ocean source of planktonic and related bacterial PM10 is potentially far greater than other sources because the area of ocean surface where phytoplankton blooms occur offshore from Oceano Dunes is tens of thousands of acres larger than the OHV riding area of the State Park.</u>** " emphasis added.

Dr. Palenik then concludes with: "Nearby coastal seawater is contributing biological material to **<u>PM10 aerosols (10 microns or less) detected and captured inland at monitoring sites</u>** using EBAMs. This likely includes whole microbes, ranging from the one micron sized bacteria to small eukaryotes less than 10 microns such as small diatoms. Potentially fragments of larger." Emphasis added

In Conclusion, Friends of Oceano Dunes is extremely concerned by the decade long political spin by the APCD and the APCO which has relied on misleading the public and other agencies by hiding data and ignoring other potential causes of the dust and silica that is impacting the Nipomo Mesa. What other data has the APCD & APCO hidden from the public?

California State Parks needs to stop all fencing and planting of vegetation, since there is no silica coming from the ODSVRA and off-shore sources of PM-10 have clearly been identified which have skewed all data to date.

Sincerely,

Jim Suty
President – Friends of Oceano Dunes

CC: Tom Roth
FoOD BOD
California State Parks

Attachment A

Friends of Oceano Dunes 2008 letter to the APCD

Jim Suty, President
3019 Archwood Circle
San Jose, CA 95148
408-242-4445
E-mail: jim@oceanodunes.org
www.oceanodunes.org

May 14, 2008

By Hand Delivery

Board Members
SLO County Air Pollution Control District
3433 Roberto Court
San Luis Obispo, CA 93401

Re: Request for an Open Process Regarding Phase II of the Nipomo Mesa Particulate Study

Dear District Board Members:

This letter is being submitted by Friends of Oceano Dunes, Inc. ("Friends"), a California not-for-profit corporation representing users of Oceano Dunes State Vehicle Recreational Area ("ODSVRA"). Friends is concerned about the closed nature of the San Luis Obispo County Air Pollution Control District's Nipomo Mesa Particulate Study, Phase II (Study). Friends asks that the District provide a more transparent study, allowing for public scrutiny and input before the study continues further.

The District Should Release Relevant Documentation on the Particulate Matter Study to the Public Now

To date, the District's staff has refused to release any documentation or data related to Phase II of the Study on the basis that the information is "scientific." Friends believes that is not a legitimate justification for concealing information about the Study from the public. Many public citizens and Friends' members have scientific backgrounds and knowledge that would allow them to comment intelligently on the Study, and the methodologies and assumptions used in the Study.

The Study's Underlying Methodology, Baseline Data and Assumptions Should Be Subject to Public Scrutiny Before the Particulate Matter Study Is Fully Implemented, Not After It Is Completed

As a matter of public policy, the Study's u**nderlying methodology, baseline data and assumptions should be tested by public input and comment before the Study is fully implemented – not after it is completed. The public and Friends' members and consultants have knowledge and insights that would provide a more analytically rigorous,**

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fair and balanced monitoring study. Because the District has chosen to conceal Phase II of the Study and any detail on its methodologies, the District staff risks producing a flawed analysis – an outcome that could be avoided with public input at the beginning of the process.

The District Is Failing to Provide Adequate Prior Notice of the Issues Being Considered At Its Board Meetings

Previously, the District posted Board agendas on its website prior to the Board meeting. For the past 6 months or so, the District staff ceased posting agendas on the District website before the Board meeting. Thus, it is now much more difficult for the public to ascertain what issues the Board is considering at its meetings. In fact, there was no prior notice on the website that the Board was considering moving forward with Phase II of the Study.

The Timing of the Particulate Matter Study Is Suspect

In addition to our concern about the secretive nature of the Study, Friends is also concerned about the timing of the Study. The Study appears to have been initiated just as SLO County began serious discussions with the California Department of State Parks and Recreation regarding the possible sale of the La Grande Tract in ODSVRA. The concurrent timing raises concerns that the Study is designed to give the County leverage in the negotiations, in essence, politics under the guise of science. Friends respectfully asks that the District explain why the Study was initiated now during the very time the County was negotiating the sale of the La Grande Tract.

Sincerely,

Jim Suty
President – Friends of Oceano Dunes

CC: Tom Roth
FoOD BOD

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Attachment B

Determination of Airborne Crystalline Silica (Quartz) Exposure

DETERMINATION OF AIRBORNE CRYSTALLINE SILICA (QUARTZ) EXPOSURE
at
Oceano Dunes State Vehicular Recreation Area
San Luis Obispo County, California

Date: **December 14, 2017**

Report to: **Mat Fuzie, Deputy Director**
Off Highway Motor Vehicle Recreation Division
California Department of Parks and Recreation
1725 23rd Street, Suite 200
Sacramento, CA 95816

Prepared by: **John W. Kelse, Industrial Hygienist**
152 Pulaski Highway
Ansonia, CT 06401

Overview: On November 15, 2017, personal air samplers were deployed within the off-highway vehicle (OHV) riding area of Oceano Dunes State Vehicular Recreation Area (SVRA). Oceano Dunes SVRA is a state park located in south San Luis Obispo County, California and managed by the Off Highway Motor Vehicle Recreation Division (OHMVR Division) of the California Department of Parks and Recreation (DPR).

The air samplers were affixed in the breathing zones of a maintenance worker deployed to the OHV riding area of the SVRA for approximately six hours to construct and repair fences, and to a person simulating an OHV recreationist who traversed the dunes for approximately seven hours in an open-air recreational off-highway vehicle (ROV). Additionally, a respirable dust air sampler and a total dust air sampler were affixed to the S1 meteorological tower (located in the west-central portion of the OHV riding area) at approximate adult-breathing-zone height for approximately seven hours to represent ambient conditions concurrent with the other air sampling.

The air samplers were deployed by Will Harris, a geologist with the California Geological Survey. Mr. Harris has witnessed the proper deployment of air samplers on previous investigations by this author, and in this investigation, he worked as competent surrogate in the placement and operation of the provided air samplers.

Sampling was undertaken to determine total (all size) dust, respirable particulate (particulate 10 microns or smaller in size), and respirable crystalline silica or quartz – the most common form of crystalline silica. Sampling occurred on a dry day with generally light wind conditions (see appended sampling recording sheet). The sampling undertaken in this study was limited and considered exploratory in nature.

Results: Analytical results (attached) indicate none of the samples obtained by this investigation exceeded the current occupational health standard for total dust, respirable dust or quartz. Crystalline silica (quartz) results were below the detection limit for the analytical technique applied and volume of air filtered for each sample (see appended data sheet).

Discussion: Given the respiratory risks associated with crystalline silica exposure, the amount of respirable crystalline silica that may be within dust generated in a beach and dune environment is of understandable interest. A significant portion of beach and dune sands typically includes grains of or grains containing crystalline silica (quartz). Respirable crystalline silica particulate, however, is typically 100 times or more finer than crystalline and amorphous silica particulate found in ordinary beach sand and therefore not generally viewed as a concern. Expanded discussion on the general risk of respirable crystalline silica, particle size and occupational versus general environmental exposures can be found in numerous references (https://www.osha.gov/dsg/topics/silicacrystalline/; https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/crystalline-silica; https://www.federalregister.gov/documents/2016/03/25/2016-04800/occupational-exposure-to-respirable-crystalline-silica, etc.).

One minor anomaly was noted in the reviewed results. The total dust level (in weight) was slightly greater than the total respirable particle fraction in weight for the fixed sample. This would not be expected since respirable dust is a portion of the total dust and quartz, in turn, is a portion of this respirable fraction. However, this disparity is slight given the low dust levels collected and is sometimes seen due to the positioning of total dust cassette filter (inlet facing down or up too much, etc.). Importantly, the crystalline silica (quartz) content in the ambient respirable sample (Number 51894, collected on a different filter cassette at a different orientation) was below detection limit for the analysis despite the higher respirable level. That result is consistent with the personal crystalline silica (quartz) results and is another indicator of the importance of particle size with respect to crystalline silica in beach sand.

The United States Occupation Safety and Health Administration (OSHA) standard, known as the permissible exposure limit (PEL), for respirable crystalline silica dust in an industrial setting is a concentration of 50 micrograms per cubic meter of air averaged over an 8-hour work day. The PEL for respirable crystalline silica focuses on exposures that involve the mechanical breakdown of the crystalline particulate to respirable size (10 microns or smaller). Such exposures are typically found in workplace settings involving grinding, abrasive blasting, sanding, drilling concrete, etc. Similar crystalline silica particle breakdown to respirable size in the natural environment rarely, if ever, occurs. For this reason sampling during higher wind days is unlikely to show a significant increase in respirable crystalline silica levels even though overall airborne dust levels would be higher.

Further, the frequency and duration of exposure to crystalline silica (quartz) **must** always be considered when assessing risk potential. As mentioned, the OSHA PEL for respirable crystalline silica is based on exposure for an 8-hour workday, performed five days per week for 40 years. This standard is believed to be adequately protective for pneumoconiosis (silicosis in this instance) and cancer of the lung in an industrial workplace setting. It is an extremely conservative number (overly protective) if it is used for evaluation purposes to assess associated risk in a natural environment setting such as a beach and associated sand dunes.

Conclusion: The crystalline silica (quartz) analytical results for the air filter samples collected in the OHV riding area of Oceano Dunes SVRA on November 15, 2017 were below the detection limit for the analytical technique applied and volume of air filtered, and as such provided no evidence of a realistic pulmonary (inhalation) risk with respect to respirable crystalline silica. The desirability of additional, more expansive air sampling should include consideration of the above discussion regarding crystalline silica particle sizes differences in industrial versus natural environments.

A request was made by DPR to review and comment upon prior respirable crystalline silica analysis for air filter samples collected by others at the CDF site, an air quality monitoring station managed by the San Luis Obispo County Air Pollution Control District that is inland from the Oceano Dunes SVRA. That review document is appended to this report.

Attachments: Results Report to John Kelse from the Hartford Risk Engineering Laboratory, December 8, 2017, Sampling Data Recording Sheet, November 15, 2017, Dust Sampling Data Sheet and Calibration of Pumps Record.

Comments Concerning Crystalline Silica Monitoring Analytical Results Obtained from Air Sampling at the CDF Station, 2391 Willow Road, Arroyo Grande, California, in April/May/June of 2017, John Kelse, December 14, 2017.

DUST SAMPLING DATA SHEET:

Sampling Date: November 15, 2017
Sample Location: Oceano Dunes SVRA, San Luis Obispo County, California
LAB REF# 33097: The Hartford – Risk Engineering Laboratory
AIHA-LAP, LLC Accredited Laboratory #100124

Analysis: Total dust by gravimetric (NIOSH Method 0600M)
Quartz (free silica) by XRD (NIOSH Method7500)

OSHA Workplace Regulatory Standards Applied:

Total Dust (includes inhalable):	10 milligram/meter^3 8 hr. Time-Weighted Average (TWA)
Respirable Dust:	3 milligram/meter^3 8 hr. TWA
Quartz (free silica):	0.05 milligram/meter^3 8 hr. TWA (Respirable fraction).

Sample #	Sample Time	Liter Vol.	Location	Contaminant	mg/m^3 Found 8 Hr equiv.
51621	6 hr 12 min.	635	Per. Marko Morales, Maint. of fences and dunes	Respirable Dust Quartz	<0.039 <0.016
51864	7 hr 1 min.	703	Per. Will Harris, General area, dunes/rec. area	Respirable Dust Quartz	<0.036 <0.015
51899	7 hr 2 min.	846	Fixed Sampling at S1 Tower	Total Dust	0.14
51894	7 hr 2 min.	713	Fixed Sampling at S1 Tower	Respirable Dust Quartz	1.1 <0.015

THE HARTFORD - RISK ENGINEERING LABORATORY
ONE HARTFORD PLAZA
HARTFORD, CT 06155
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THE HARTFORD

AIHA-LAP, LLC ACCREDITED LABORATORY #100124

RESULTS REPORT :

JOHN KELSE
RT VANDERBILT COMPANY
30 WINFIELD STREET
NORWALK, CT 06855

LABORATORY NUMBER: 33097
ACCOUNT: RT VANDERBILT CO.
ACCOUNT ADDRESS: NORWALK, CT

DATE COLLECTED :
DATE RECEIVED : 12/01/2017
REPORT DATE : 12/8/17

LABORATORY NUMBER: 33097

FIELD ID	VOL (LITERS)	TIME (MINS)	ANALYTE	MG	MG/M3	PPM	MRL (MG)	REFERENCED METHOD:	ANALYSIS DATE
AA71781 51621	635								
			RESPIRABLE DUST	< 0.025	< 0.039		0.025	GRAV/NIOSH 0600M	12/4/17
			QUARTZ	< 0.010	< 0.016		0.010	XRD/NIOSH 7500 M	12/8/17
AA71782 51864	703								
			RESPIRABLE DUST	< 0.025	< 0.036		0.025	GRAV/NIOSH 0600M	12/4/17
			QUARTZ	< 0.010	< 0.015		0.010	XRD/NIOSH 7500 M	12/8/17
AA71783 51899	846								
			TOTAL DUST	0.12	0.14		0.025	GRAV/NIOSH 0500M	12/4/17
AA71784 51894	713								
			RESPIRABLE DUST	0.80	1.1		0.025	GRAV/NIOSH 0600M	12/4/17
			QUARTZ	< 0.010	< 0.015		0.010	XRD/NIOSH 7500 M	12/8/17
AA71785 CONTROL 52402	0								
			RESPIRABLE DUST	< 0.025	---		0.025	GRAV/NIOSH 0600M	12/4/17
			QUARTZ	< 0.010	---		0.010	XRD/NIOSH 7500 M	12/8/17

NOTE: The concentration values (e.g. MG/M3, PPM) were calculated at the laboratory using data and information (times and/or flow rates) supplied to the laboratory by the submitter.
NOTE: If applicable, organic sampling tubes are analyzed separately. "<" means not measured at the method reporting limit (the amount of this material that can reliably be reported based on analytical conditions).
NOTE: Sample results have not been corrected for the amount of contamination found on the field blank sample, unless otherwise noted.
NOTE: Reported values have been rounded. However, calculations were performed using intermediate unrounded results.
NOTE: The reported results relate only to the items tested. Unless otherwise noted, all samples were received at the laboratory in satisfactory condition.
ABBREVIATIONS: MG = Milligrams MG/M3 = Milligrams per Cubic Meter of Air PPM = Parts Per Million MRL = Method Reporting Limit Referenced Method "M" = Modified

Laboratory Analysts : D. White
A. Neuman
R. Ross
A. van der Swaagh
R. Costa
L. Schoeplein

ROBERT ROSS
LABORATORY TECHNICAL MANAGER

Nov. 15, 2017

SAMPLING DATA RECORDING SHEET:

Filter #	Pump #	TIME ON	TIME OFF	TYPE OF SAMPLE (PERSONAL OR FIXED) NAME & ACTIVITY
51621 (Respirable)	12	08:27 (cal. 1.704)	14:15	Personal. Marko Morales, Maintenance of Fences in Dunes
51894 (Respirable)	5	09:21 (cal 1.708)	16:23	Ambient cyclone @ S1 Tower
51864 (Respirable)	10	09:27 (cal. 1.701)	1628	Personal. Will Harris, Throughout Dunes, recreation Sim.
51899 (Total Dust)	4	0921 (cal. 2.01)	16:23	Ambient no cyclone @ S1 Tower

Control Filter # 52402

Date of Survey: Nov. 15, 2017

Available Info on conditions: (temps, wind aspects, rain, etc.)
7:30 AM Partly cloudy, light wind, 51°F,
9:20 AM Partly cloudy, light west wind
10:30 Modest Breeze W.NW 6?°F
4:20 PM 62°F light to modest Wind from west. Mostly cloudy

Describe dust exposure – what the mineral composition of this exposure is likely to be – particularly for possible interferences. Coastal Dune environment. Crustal material

CALIBRATION RECORD:

Pump #	Filter #	Start L/ min.	End L/min.	L/min Difference	Final L/min.	Min. Time Sampled	**LITER VOLUME**
12	51621	1.704	1.710	+ .006	1.707	372	**635**
10	51864	1.701	1.63	- .071	1.67	421	**703**
4	51899	2.01	2.00	- .01	2.005	422	**846**
5	51894	1.708	1.680	- .018	1.69	422	**713**

Comments Concerning Crystalline Silica Monitoring Analytical Results Obtained from Air Sampling at the CDF Station, 2391 Willow Road, Arroyo Grande, California, in April/May/June of 2017

BY: **John W. Kelse , Industrial Hygienist**
Date: **December 14, 2017**

At the request of the California Department of Parks and Recreation (DPR), I have reviewed airborne crystalline silica sampling results obtained from air filter samples collected at 2391 Willow Road, Arroyo Grande, California. This address is the location of an air quality monitoring station, known as the CDF Station, managed by the San Luis Obispo County Air Pollution Control District (SLOAPCD). The CDF location is approximately 2.5 miles from the ocean shoreline and about one mile from the eastern boundary of the Oceano Dunes State Vehicular Recreation Area (SVRA), a state park managed by the DPR. The reviewed analytical reports, from Forensic Analytical Laboratories of Hayward, California, are attached to this document.

It is presumed the samples were collected and analyzed as part of an environmental monitoring program undertaken by the SLOAPCD. According to data presented on the analytical reports, a total of four air filter samples were collected and analyzed. The samples were collected on April 25 and 27, 2017, May 12, 2017, and June 12, 2017. Samples were analyzed using National Institute for Occupational Safety and Health (NIOSH) Method 7603 (with infrared, or IR, analysis) and NIOSH Method 500/600 Modified. It is assumed, since the methods employed require respirable fraction analysis, that the crystalline silica (quartz) sample content represents respirable crystalline silica (particulate that is 10 microns or smaller in aerodynamic size) with collection times spanning 6 to 8 hours.

Analytical Method: With respect to the analytical method applied, it is my understanding that IR analysis is a reliable analytical methodology (originally developed for detecting crystalline silica in coal dust) with reasonable inter-laboratory consistency when the principle interference (amorphous silica) is predictably removed or minimized. An alternative analysis, NIOSH Method 7500 (using x-ray diffraction or XRD), however, is a more widely applied analytical approach in occupational-crystalline-silica-exposure settings as it is less subject to silica polymorph interferences as a result of the phosphoric acid treatment applied with this method. Good inter-laboratory agreement exists with this method as well. In general, I am aware that XRD analysis (using NIOSH Method 7500) has become the most preferred analytical approach over the last 10 years or so and the one most applied when comparing to crystalline silica airborne exposure to workplace exposure limit standards.

Results: The analytical results show that crystalline silica concentrations, if present at all, generally fall at or below the detection limit of the analytical method used (Three of the four sample results reported at the 10 microgram detection limit of the analysis; one sample reported at 20 micrograms). More recent XRD analysis per NIOSH Method 7500 of air filter samples collected within the sand dunes of Oceano Dunes SVRA has shown similar below-detection limit-crystalline silica (quartz polymorph) results. Such consistent trace- or zero-detected levels strongly suggest the absence of a warranted crystalline silica risk in the coastal setting where the samples were collected.

It has been pointed out that while beach sand typically contains crystalline silica, the particle size is 100 or more times greater than the respirable size that is linked to human risk (https://www.osha.gov/silica/Silica_FAQs_2016-3-22.pdf; https://www.cdc.gov/niosh/pdfs/silicax.pdf).

In my own professional experience, where for more than 50 years I have sampled for airborne crystalline silica particles in industrial settings, I've often been surprised at how little respirable quartz is recorded in mineral dust environments with high crystalline silica content (some upwards of 50%). I find this linked to how much energy it apparently takes to produce very fine quartz particulate.

In the reviewed analytical results, it's interesting that crystalline silica polymorphs (quartz, cristobalite and tridymite) are addressed separately. Generally, quartz is by far the most common form of crystalline silica encountered. I have rarely encountered cristobalite (typically linked to volcanic deposits in origin) and never tridymite. Nonetheless, it is beneficial to examine this breakdown, particularly in a new setting, so it is appreciated that the analysis has been performed. In the crystalline silica analytical method most commonly used (NIOSH Method 7500), the total silica content is reported, which includes polymorph content.

Standards: When reporting crystalline silica airborne particulate levels it is of obvious interest to compare these levels to some standard for "meaning." The current United States Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for respirable crystalline silica dust is 50 micrograms per cubic meter of air (0.05 milligrams per cubic meter of air) over an 8 hour workday, 5 days per week for 40 years. Some health researchers feel this limit is overly restrictive and argue that there is no evidence that compliance to the previous OSHA PEL (100 micrograms per cubic meter of air) was inadequately protective. These arguments are laid out in the OSHA rulemaking record (https://www.federalregister.gov/documents/2016/03/25/2016-04800/occupational-exposure-to-respirable-crystalline-silica).

Conclusion: Whether one puts faith in the reliability of the current occupational health standard for crystalline silica or not, my review of the presented analytical results render these questions essentially mute in my opinion. The analytical reports of the air filter samples collected at the CDF air monitoring station in April, May, and June 2017 offer no evidence of a realistic pulmonary (inhalation) risk with respect to crystalline silica.

Respectfully,

John Kelse

Attachments: Forensic Analytical Laboratories, Final Report to County Air Pollution Control District Project Manager, Report Number M184679, May 17, 2017.

Forensic Analytical Laboratories, Final Report to County Air Pollution Control Dist., Report Number M184678, June 30, 2017.

Forensic Analytical LABORATORIES

Crystalline Silica in Air with Gravimetry

by Fourier Transform Infrared (FTIR) Spectroscopy

NIOSH Method 7603 / NIOSH Method 500/600 Modified

County Air Pollution Control Dist.
Project Manager
San Luis Obispo
3433 Roberto Ct.
San Luis Obispo, CA 93401

Client ID: 7240
Report Number: M184679
Date Received: 05/11/17
Date Analyzed: 05/17/17
Date Printed: 05/17/17
First Reported: 05/17/17

Job ID / Site: PO #51208 - CDF, 2391 Willow Rd, Arroyo Grande, CA
Date(s) Collected: 4/25/17 & 4/27/17

FALI Job ID: 7240
Total Samples Submitted: 2
Total Samples Analyzed: 2

Sample Number	Lab Number	Volume	Analyte	Result	Result Units	Reporting Limit*
PO111	30767521	990 L	Quartz	0.020	mg/m3	0.010
			Cristobalite	< 0.010	mg/m3	0.010
			Tridymite	< 0.010	mg/m3	0.010
			Total Silica	**0.02**	**mg/m3**	**0.010**
			Dust	**< 0.2**	**mg/m3**	**0.2**
PO108	30767522	990 L	Quartz	0.010	mg/m3	0.010
			Cristobalite	< 0.010	mg/m3	0.010
			Tridymite	< 0.010	mg/m3	0.010
			Total Silica	**0.01**	**mg/m3**	**0.010**
			Dust	**< 0.2**	**mg/m3**	**0.2**

* The reporting limit represents the lowest amount of analyte that the laboratory can confidently detect in the sample, and is not a regulatory level. The units for the reporting limit are the same as the units for the final results.

Lawrence E. Wayne, Applied Microscopy Supervisor, Hayward Laboratory

Forensic Analytical LABORATORIES

Crystalline Silica in Air with Gravimetry

by Fourier Transform Infrared (FTIR) Spectroscopy

NIOSH Method 7603 / NIOSH Method 500/600 Modified

County Air Pollution Control Dist.
Karl Tupper
San Luis Obispo
3433 Roberto Ct.
San Luis Obispo, CA 93401

Client ID: 7240
Report Number: M186478
Date Received: 06/23/17
Date Analyzed: 06/30/17
Date Printed: 06/30/17
First Reported: 06/30/17

Job ID / Site: PO #51208, CDF, 2391 Willow Rd., Arroyo Grande
Date(s) Collected: 05/12/17 & 06/12/17

FALI Job ID: 7240
Total Samples Submitted: 2
Total Samples Analyzed: 2

Sample Number	Lab Number	Volume	Analyte	Result	Result Units	Reporting Limit*
PO109	30771942	1,224 L	Quartz	< 0.008	mg/m3	0.008
			Cristobalite	< 0.008	mg/m3	0.008
			Tridymite	< 0.008	mg/m3	0.008
			Total Silica	**< 0.008**	**mg/m3**	**0.008**
			Dust	**< 0.05**	**mg/m3**	**0.05**
PO129	30771943	1,004 L	Quartz	0.010	mg/m3	0.010
			Cristobalite	< 0.010	mg/m3	0.010
			Tridymite	< 0.010	mg/m3	0.010
			Total Silica	**0.01**	**mg/m3**	**0.010**
			Dust	**< 0.05**	**mg/m3**	**0.05**

* The reporting limit represents the lowest amount of analyte that the laboratory can confidently detect in the sample, and is not a regulatory level. The units for the reporting limit are the same as the units for the final results.

Lawrence E. Wayne, Applied Microscopy Supervisor, Hayward Laboratory

Attachment C

Marine Contributions to Aerosol Particulates in a Coastal Environment

State of California • Natural Resources Agency
Department of Conservation
California Geological Survey
801 K Street • MS 12-30
Sacramento, CA 95814
(916) 445-1825 • FAX (916) 445-5718

Edmund G. Brown Jr., *Governor*
John G. Parrish, Ph.D., *State Geologist*

MEMORANDUM

DATE: MARCH 12, 2018

TO: Mat Fuzie
Deputy Director
California State Parks
Off-Highway Motor Vehicle Recreation Division
1725 23rd Street, Suite 200
Sacramento, CA 95816

FROM: Will Harris
Senior Engineering Geologist

SUBJECT: Scripps Study of Marine Contributions to Aerosol Particulates
Oceano Dunes State Vehicular Recreation Area, San Luis Obispo County, California.

Deputy Director Fuzie,

Attached herein, please find the March 6, 2018 report entitled "Marine Contributions to Aerosol Particulates in a Coastal Environment." This document was prepared by Dr. Brian Palenik of the Scripps Institution of Oceanography at UC San Diego (Scripps) as part of his investigation of particulates found on ocean-facing structures at the Oceano Dunes State Vehicular Recreation Area (Oceano Dunes).

As you know, every spring in south San Luis Obispo County (south county), strong prevailing winds blowing from over the ocean, out of the west-northwest, provide the key force that gives shape to the coastal sand dunes in the south county. Because of the prevailing winds, conditions offshore from Oceano Dunes and vicinity are ideal for large planktonic blooms, particularly during the spring (Walter, Armenta et al., 2018; Garcia-Reyes and Largier, 2012; Tognazzini, 2009). The west-northwest winds run parallel to the coast from Point Buchon to Point San Luis, pushing warm surface water towards and along that part of the shore that faces west (e.g., Oceano Dunes). Deeper, colder, nutrient-rich seawater upwells offshore from the west-northwest line of coast in response to the displaced surface water. When this water reaches the surface, sunlight warms it causing various planktonic species to grow. The amount of plankton varies based on seasons and conditions, but humpback whale and other cetacean feeding activity in the area provides anecdotal evidence that the production of plankton can be prolific (https://www.youtube.com/watch?v=GeD5i0DadVA). Overall, the amount of upwelling that occurs may be increasing because the strength of the northwesterly winds during the spring and summer has slowly increased over time based on a review of wind data from the Diablo Canyon nuclear power plant, which is located at Point Buchon (Lindsey, 2013).

During prevailing wind episodes, as observed at Oceano Dunes, a film of very fine grit accumulates on the ocean-side surface of just about anything the stands above the dunes. Posts, signs, fencing, even vegetation, become coated with this material (Figure 1). Under microscope the material appears to be biologic, possibly planktonic (Figure 2).

Sea/air interactions related to plankton blooms have been demonstrated by several researchers, including those at the Scripps Institution of Oceanography. For example, aerosolized planktonic algae have been shown to influence the formation of coastal clouds and fog (Prather, Bertram et al., 2013).

Dr. Brian Palenik, professor of marine biology at Scripps, has examined these interactions. He was intrigued by the aforementioned grit at Oceano Dunes and so designed a study that examined the biological signatures in seawater offshore from Oceano Dunes and that of the very fine grit material (less than 10 microns in diameter) collected from a variety of media, including filter tapes from EBAM air samplers deployed in the sand dunes. Samples were collected in 2014, 2015, and 2016 and examined for the presence of marine prokaryotes (bacteria) and marine eukaryotes, such as phytoplankton diatoms, using DNA sequence analysis.

From the analyses performed on samples of seawater, dune sand, surf foam, and the airborne grit, Dr. Palenik was able to determine that “nearby coastal seawater is contributing biological material to PM10 aerosols (10 microns or less) detected and captured inland at monitoring sites using EBAMs. This likely includes whole microbes, ranging from the one micron sized bacteria to small eukaryotes less than 10 microns such as small diatoms.” Further, Dr. Palenik notes, “We did find diatom DNA on EBAM filters from Chaetoceros calcitrans and Thalassiosira pseudonana, two small marine species that are less than 10 microns. DNA from these diatoms was found on some near-beach fencing but not in dune sand samples, suggesting they are transported as whole-cell aerosols from seawater to the EBAM filters.”

The findings from this work have bearing on the ongoing efforts to mitigate airborne PM10 detected in Nipomo Mesa (Mesa), which is approximately two miles downwind from Oceano Dunes. At present, all mitigation efforts are focused on the reduction of saltation-derived dust emanating from locations within the 1500 acre off-highway vehicle (OHV) riding area of Oceano Dunes. Additionally, PM10 air dispersion modeling undertaken collaboratively with the California Air Resources Board and the San Luis Obispo County Air Pollution Control District considers saltation-derived dust from the OHV riding area of Oceano Dunes as the sole source of PM10 ultimately detected on the Mesa. As demonstrated by the Scripps investigation, the sourcing of airborne PM10 detected in this coastal setting is more complex, a function of several phenomena that occur on land, the ocean, and in the air. An ocean source of planktonic and related bacterial PM10 is potentially far greater than other sources because the area of ocean surface where phytoplankton blooms occur offshore from Oceano Dunes is tens of thousands of acres larger than the OHV riding area of the State Park.

In the cover letter to his report, Dr. Palenik notes that the findings of his investigation have been presented at the 2018 Ocean Sciences Meeting, which is sponsored by the American Geophysical Union, among others. Dr. Palenik also anticipates publishing the work in a scientific journal, and he intends to conduct further work in the area to more completely quantify the marine biological signature of PM10 dust detected in the south county.

I am available for any questions you may have regarding the Scripps investigation or related topics.

Respectfully submitted,

Original signed by:

Will J. Harris, PG 5679, CEG 2222, CHg 750
Senior Engineering Geologist

Concur:

Original signed by:

William R. Short, PG 4576, CEG 1429, CHg 61
Supervising Engineering Geologist

Attachments: Figures 1 and 2;
Scripps Investigation – Marine Contributions to Aerosol Particulates in a Coastal Environment by Dr. Brian Palenik and Maitreyi Nagarkar, March 6, 2018.

References:

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Tognazzini, 2009. Mechanisms for temporal change in phytoplankton composition in San Luis Obispo Bay California. M.S. Thesis, California State Polytechnic University, San Luis Obispo. August 2009.

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Figure 1. Grit on plasticized screen, Plover Exclosure fence, Oceano Dunes SVRA, May 2011 (photo by Will Harris).

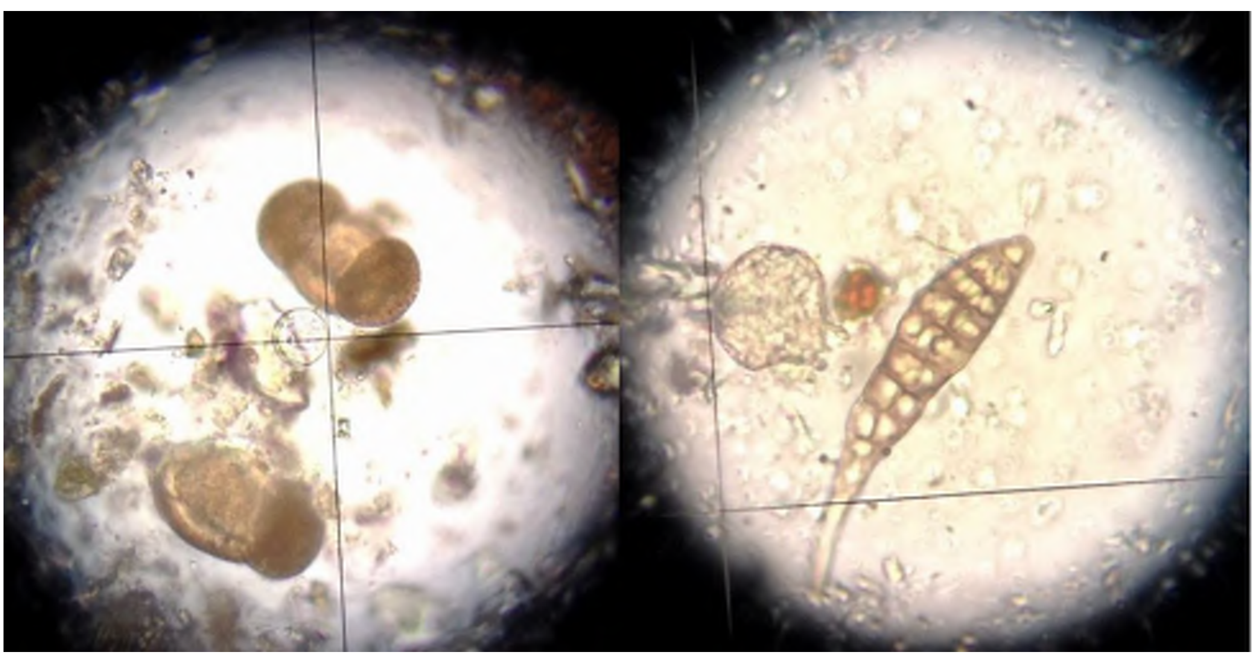

Figure 2. Photomicrographs of grit particles that were collected from plasticized screen shown in Figure 1 above (photomicrographs by Will Harris).

Will Harris
Senior Engineering Geologist
California Geological Survey
801 K Street, MS 12-30
Sacramento, CA 95814

March 6, 2018

Dear Mr. Harris,

Please find attached our report of findings regarding the marine contribution to aerosolized particulates in south San Luis Obispo County (south county). As stated in the report, our analysis shows nearby coastal seawater is contributing biological material to PM10 aerosols (10 microns or less) detected and captured inland at EBAM monitoring sites within the dune environment of the south county. Detected marine-derived materials within the PM10 fraction include prokaryotes (bacteria) and eukaryotes, such as small diatoms.

Our findings from this investigation have been presented at the 2018 Ocean Sciences Meeting co-sponsored by AGU, ASLO and TOS societies. Additionally, we are in the process of submitting this work to a scientific journal for publication.

We would like to extend our appreciation to the California Geological Survey and to the California Department of Parks and Recreation for the assistance and access that made our investigation possible. We look forward to continued collaboration in future endeavors.

Sincerely,

Brian Palenik
Professor of Marine Biology
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bpalenik@ucsd.edu
858-534-7505

Report: Marine Contributions to Aerosol Particulates in a Coastal Environment

Brian Palenik
Maitreyi Nagarkar

Scripps Institution of Oceanography
University of California San Diego
La Jolla, CA 92093-0202
Contact information: bpalenik@ucsd.edu
Submitted 3/6/2018

Introduction

There is increasing interest in the contribution of marine-derived aerosols to particulates found over land. These marine aerosols may contain inorganic, organic, or biological materials. In studies of the marine atmosphere, about 10% of particulate matter by volume has been attributed to biological material, introduced either from land or through mechanisms such as bubble bursting at the sea surface (Matthias-Maser, Obolkin et al. 2000) (Aller, Kuznetsova et al. 2005) (Matthias-Maser, Brinkmann et al. 1999), with the latter mechanism likely dominant.

Once marine-derived aerosols move over land they can have multiple effects such as contributing to nucleating water droplet formation (cloud condensation nuclei) and thus fog/cloud formation or even potentially on human health (Prather, Bertram et al. 2013). As an example of the latter, some toxic marine phytoplankton have been found to produce aerosolized toxins and subsequent health effects (Hoagland, Jin et al. 2009, Kirkpatrick, Fleming et al. 2011). There has been an increasing appreciation that marine aerosols can contain microbes both prokaryotic and eukaryotic and these may vary with seawater conditions and distance from land (Cochran, Laskina et al. 2017, Rastelli, Corinaldesi et al. 2017) (Hiraoka, Miyahara et al. 2017) (Mayol, Arrieta et al. 2017) (Xia, Wang et al. 2015) (Woo, Brar et al. 2013) (Dueker, O'Mullan et al. 2012) (Dueker, Weathers et al. 2011) (Urbano, Palenik et al. 2011).

Here we determined the potential link between local marine waters and the composition of airborne material blown shoreward by prevailing winds to the coastal dunes in south San Luis Obispo County. This site was chosen as it shows seasonally high winds thought to promote local phytoplankton blooms and associated bacteria and is involved in local sand dune formation at Oceano Dunes State Vehicular Recreation Area (Oceano Dunes). Oceano Dunes is a California state park in San Luis Obispo (SLO) County that lies within the northern end of the Guadalupe Nipomo Coastal Dune Complex. The dune complex consists of more than 18,000 acres of coastal dunes that stretch from southern San Luis Obispo County into northern Santa Barbara County. The microbial community of the dunes has not been explored. Oceano Dunes SVRA consists of about 3,600 acres, with about 1,500 of those acres devoted to camping and off-highway vehicle (OHV) recreation.

We used DNA sequence analysis as a qualitative measure of compositional information, with 16S rRNA gene sequences as a measure of bacterial aerosols and 18S rRNA gene sequences a measure of eukaryotic-derived aerosols. DNA sequences from marine microbes typically found in seawater was used as an indicator of a marine component of local waters finding its way into the total pool of airborne particulates. Initially we compared the sequences from the airborne particulates only to sequences found from our seawater samples, but later on we also incorporated marine sequences from public databases. We included analysis of a range of particulates including those caught on dune fencing to the very fine material (approximately 10 microns in diameter, also called PM10) that could affect air quality. We show that a commercial environmental beta particle attenuation monitor (EBAM) system (Met One Instruments, Inc) often used for air quality monitoring can be analyzed for microbial components using DNA sequence analyses of their sampling "tapes".

Results

32 samples were collected from seawater, beach foam, beach and dune sand, or air filters (EBAM tapes) at several different sites on different dates (Table 1). Total DNA was extracted from each of these and the Illumina platform was used to sequence either the 16S (for bacterial community composition) or 18S (for eukaryotic community composition) amplicon. Sequences were then clustered into predicted species (referred to as operational taxonomic units, or OTUs) based on sequence similarity and classified using the Silva v123 database.

Significantly, DNA from marine microbes in seawater samples was found translocated shoreward. It was caught on different particle collecting systems including dune wind fencing and screens and on commercial E-BAM systems, thus providing information about the contribution of marine aerosols to inland particle composition (Table 1, Supplemental Table 1)

We used the OTUs found in the three seawater samples (from two different dates) to identify "marine" bacterial and eukaryotic OTUs, against which we compared the sequences found at the other sites. From the 16S data, we found that between all the seawater samples there were 1348 OTUs with at least two sequences present and 1596 OTUs with a least one sequence present. Many of these OTUs were known marine species such as *Pelagibacter*.

We then quantified the presence of these seawater OTUs in the EBAM air samples and samples from the other sites. We calculated the proportion of total sequences from each site that represented marine OTUs (OTUs found in the seawater samples) by adding the number of sequences represented by marine OTUs and dividing by the total number of sequences from the sample. Marine bacterial sequences collected on the EBAM filters varied from 0 to 44 % of the total sequences obtained from a specific filter, showing a large component of marine bacteria to be likely present in the EBAMs. EBAM data is shown in bold in Table 1.

We combined the sequences across all the air samples to determine the top 25 most abundant bacterial OTUs on the air filter samples from the EBAMs (Table 2). The most abundant non-marine bacterial taxa were typical soil microbes such as *Dyella*. Four of the twenty five top OTUs were putative marine bacteria: *Fluviicola, Amylibacter, Paracoccus,* and a *Pseudomonas* seen in seawater, with *Fluviicola* and *Amylibacter* being the two most clearly of marine origin due to their strong representation in the seawater samples. Other marine bacteria, including *Vibrio* species, were clearly present in some, but not all, air samples (Supplemental Table 1).

The most abundant marine microbe on the air filters was a *Fluviicola like species* from the family Cryomorphaceae and this microbe was also the most abundant microbe in the beach foam sample (Table 1). In addition, two other beach foam samples from San Diego were also analyzed and found to be dominated by similar bacteria (data not shown).

We took the same approach with 18S rRNA amplicon sequences and used the marine seawater sample eukaryotes as an indicator of marine eukaryotic components of airborne particulates. There were 3907 OTUs found in seawater, similar to numbers found in coastal seawater in other studies (Nagarkar et al in review). Marine eukaryotic sequences collected on EBAM filters varied from 0 to 54% of the total sequences when determined using this approach.

Interestingly, no marine eukaryotic OTUs that were present in the seawater samples were found on EBAM samples from 2016, so the above analysis was not sufficient for determining the translocation of marine eukaryotic species to the air filters. However, the abundant OTUs in the 2016 EBAM samples included a marine diatom species. This OTU was also found on fencing (PS-2) very near the ocean, suggesting a seawater source. We believe that while these diatoms were not abundant in the reference seawater sample collected by lifeguards beyond the surf zone, but they may have been abundant in the seawater closer in to the beach.

Since the seawater samples we analyzed for 18S sequences did not provide a complete reference for all possible marine OTUs, we performed a second analysis where we determined if abundant aerosol 18S OTUs were of marine origin based on their DNA sequence similarity to that of common marine phytoplankton reported by others in published analyses. We used mothur (Schloss, Westcott et al.) and BLAST for this comparative sequence analysis. We added these newly marine-annotated OTUs into OTUs already identified as being in seawater samples based on their presence in the reference seawater samples. This analysis showed that all EBAM samples, including ones in 2016, contained eukaryotic marine phytoplankton DNA. The most abundant eukaryotic OTUs on EBAM filters are shown in Table 3 and include marine diatoms. It is significant that diatoms, in contrast to many other microbes, will contribute frustule silica in addition DNA to the aerosol. They will thus contribute, along with sand, to the Si content of aerosols.

In contrast to seawater and even marine sands and sediments (Probandt, Eickhorst et al. 2017) (Gobet, Böer et al. 2011), little is known about the microbiology of dune sands and whether this is a unique ecosystem or one largely similar to terrestrial soils. The microbial community of dune sand specifically from Oceano Dunes has not been studied. We thus examined the microbial composition of dune sand from areas protected from dune riding and from areas where dune off road vehicle riding is allowed. The bacterial composition of these two were largely similar. The ten most abundant 18S OTUs in four dune samples (Table 4) were not abundant in EBAMs, suggesting the dune was not a large contributor of microbes to EBAMs (but could still contribute inorganic material). However, we don't believe we have sufficient information about dune microbes to determine a specific percentage contribution of the dune microbes to aerosol sample DNA.

We also found OTUs from eukaryotic microalgae (found in BLAST but not in the seawater sample) to be present in dune sand. These were from *Trebouxia* sp. and *Apatococcus lobatus*. Their DNA sequences were similar to reported sequences from algae growing on rocks and buildings (Gorbushina and Broughton 2009, Gustavs, Schumann et al. 2016) so this may be an endemic dune population of microalgae or part of a larger terrestrial population. In addition, we found what appears to be sand mite DNA (closest relative *Micropsammus*) and nematode DNA (*Meloidogyne hapla* strain MeloHap11) suggesting also that the dune may have an interesting "ecosystem" of organisms. We also found DNA from sunflower (Helianthus pauciflorus subsp. Subrhomboideus) and slash pine (*Pinus elliottii*) presumably from pollen. From our small sample set, we found no evidence that recreational vehicles were affecting the community composition of this potential ecosystem as similar eukaryotes were found in riding and undisturbed areas.

Discussion and Conclusions

Nearby coastal seawater is contributing biological material to PM10 aerosols (10 microns or less) detected and captured inland at monitoring sites using EBAMs. This likely includes whole microbes, ranging from the one micron sized bacteria to small eukaryotes less than 10 microns such as small diatoms. Potentially fragments of larger eukaryotic phytoplankton including their DNA can be found on EBAM filters. For example, dinoflagellates are typically larger than 10 microns, but we did find some dinoflagellate DNA. The use of DNA as a marker of this contribution is largely a qualitative one, because the copy number of the 16S region can vary among bacteria (marine and soil). In some cases, we did not detect marine bacterial DNA in EBAM filters while in others the contribution appeared to be very large. The same was true of the eukaryotic contribution. Thus, the processes determining when marine aerosol contributions are large are still unknown, but are likely dependent on wind speed, the presence of phytoplankton blooms in coastal waters and possibly their susceptibility to aggregation or lysis.

We did find diatom DNA on EBAM filters from *Chaetoceros calcitrans* and *Thalassiosira pseudonana,* two small marine species that are less than 10 microns. DNA from these diatoms was found on some near-beach fencing but not in dune sand samples, suggesting they are transported as whole-cell aerosols from seawater to the EBAM filters. Interestingly, DNA from the diatom Pseudo-nitzschia was found in some EBAM samples. Some Pseudo-nitzschia species produce the toxin domoic acid with known toxicity to marine life (Ryan, Kudela et al. 2017, Zhu, Qu et al. 2017). It would be interesting to see whether domoic acid can be found in water and aerosols during blooms of this diatom species. These species are monitored on the California coast at specific monitoring sites (http://www.sccoos.org/data/habs/). It is not clear what the impact of aerosolized domoic acid would be.

We found that bacteria from the family Cryomorphaceae ((Muramatsu, Takahashi et al. 2012)) were present in beach foam and in EBAM filters. Foam was very abundant during sampling in 2016. Cryomorphaceae have been associated with phytoplankton blooms (Pinhassi, Sala et al. 2004) and diatoms (e.g. Flo-31) in (Grossart, Levold et al. 2005). This particular bacterial group and its possible association with foam and high abundance in aerosols warrants further attention. There is no information for example on whether this group could be a human allergen, although endotoxins from bacteria have been measured in aerosols (Lang-Yona, Lehahn et al. 2014).

One intriguing possibility suggested by our results is that beach foam is a causative agent of aerosols in addition to direct aerosol formation of seawater, eg sea spray. Presumably both of these mechanisms are occurring depending on the presence of phytoplankton blooms and foam formation from their decomposition. This could be further explored by sampling on dates with varying degrees of foam present.

Methods

EBAM air filters (Met One Instruments, Inc.) were cut to obtain the circular area containing the aerosols and then cut into smaller pieces and processed for standard DNA isolation from filters. Sand containing materials such screens, beach sand, and dune sand were washed with Phosphate buffered saline (PBS) containing 0.5M NaCl. The washes were filtered onto 2 x 25mm 0.2 um Supor filters and both filters were used for DNA extraction(Tai and Palenik 2009). For “orange” and “black” fencing, the fencing was washed with TE and the TE wash was used for DNA isolation. Foam was diluted with an equal volume of TE before DNA isolation.

DNA was checked for PCR quality by running a standard 16S or 18S rRNA amplification with the primers listed below. Total DNA was then sent to Research and Testing Laboratories (RTLGenomics, Lubbock, TX) for Illumina amplicon sequencing of the 16S or 18S rRNA gene. Primers used for 16S amplification were 28F (GAGTTTGATCNTGGCTCAG) and 388R (TGCTGCCTCCCGTAGGAGT). Primers used for 18S amplification were TAReukF (CCAGCASCYGCGGTAATTCC) and TAReukR (ACTTTCGTTCTTGATYRA) (Stoeck, Bass et al. 2010).

Sequences were clustered into OTUs using the pick_open_reference_OTUs.py pipeline in Qiime (Caporaso, Kuczynski et al. 2010), which assigns species-level OTUs at the 97% sequence similarity cutoff. The resulting biom file was converted into an OTU table and sequences were classified using mothur (Schloss, Westcott et al. 2009) against the Silva v128 database (Quast, Pruesse et al. 2013).

Figures and Tables

Figure 1. Map of Oceano Dunes sampling sites.

Table 1. Samples descriptions and fraction (of 1) of total DNA sequence reads from each sample that were likely of marine origin, based on comparison to either only the seawater OTUs ("SW only") or those and database-derived sequence ("SW + DB"). "Singlets removed" refers to the same sample but only including sequences present two or more times. ND, not determined. The data shows that marine microbes make substantial contributions to EBAMs, as seen in the DNA recovery from EBAM filters (bolded).

Table 2. Top 25 most abundant bacterial OTUs in EBAM samples (with all EBAM samples combined). Bold shows predicted marine bacteria (based on presence of those OTUs in the seawater samples), with the exception of *Pseudomonas*, which may be due to dune input. Dunes may be contributing some bacteria such as FFCH11085 given the abundance of this sequence in the dune reads.

Table 3. Top 25 most abundant eukaryotic OTUs found in EBAM samples. Bold shows taxa predicted by presence in seawater sample. Other marine taxa were found by taxonomic knowledge and BLAST annotation.

Table 4. The most abundant eukaryotic OTUs in four dune sand samples. These OTUs were not typically found on EBAMs. A few appear to be microbial residents in the sand while others are from nearby plants.

Acknowledgements:
This project received sampling and DNA processing help from Dr. Bianca Brahamsha (SIO), Emy Daniels (SIO), and Karl Hong (SIO). Sequencing was provided by RTLGenomics, Lubbock, TX.

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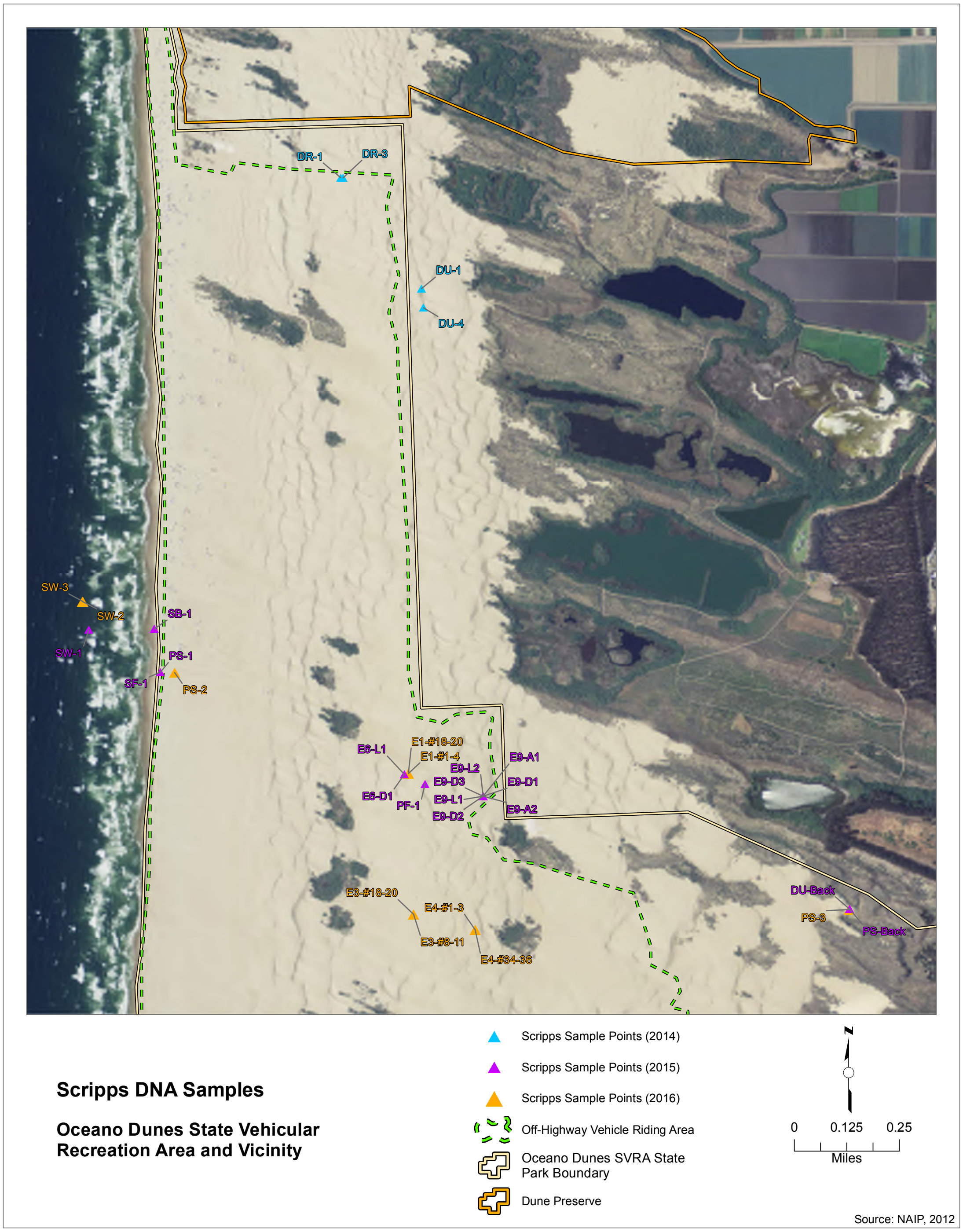

Figure 1. Map of Oceano Dunes sampling sites.

Sample Name	Sample Type	Date	Marine Fraction of Eukaryotic OTUs, all seqs, SW only	Marine Fraction of Eukaryotic OTUs, singlets removed, SW only	Marine Fraction of Eukaryotic OTUs, all seqs, SW + DB	Marine Fraction of Bacterial OTUs, all seqs, SW only	Marine Fraction of Bacterial OTUs, singlets removed, SW
DU-1	Dune	7/26/14	0.00	0.00	0.00	0.04	0.04
DU-4	Dune	7/26/14	0.00	0.00	0.00	0.00	0.00
DR-1	Dune	7/26/14	0.00	0.00	0.00	0.00	0.00
DR-3	Dune	7/26/14	0.00	0.00	0.00	0.03	0.02
SW-1	Seawater	4/7/15	1.00	1.00	1.00	1.00	1.00
SB-1	Beach Sand	4/7/15	0.37	0.37	0.37	0.57	0.49
E6-L1	**Air**	**2015**	**0.03**	**0.03**	**0.03**	**0.45**	**0.44**
E6-D1	**Air**	**2015**	**0.55**	**0.54**	**0.55**	**0.05**	**0.05**
E9-A1	**Air**	**2015**	**0.19**	**0.19**	**0.19**	**0.20**	**0.18**
E9-A2	**Air**	**2015**	**0.71**	**0.34**	**0.71**	**0.45**	**0.41**
E9-L1	**Air**	**2015**	**0.27**	**0.25**	**0.30**	**0.13**	**0.13**
E9-L2	**Air**	**2015**	**0.17**	**0.17**	**0.47**	**0.12**	**0.09**
E9-D1	**Air**	**2015**	**0.26**	**0.22**	**0.32**	**0.15**	**0.14**
E9-D2	**Air**	**2015**	**0.00**	**0.00**	**0.20**	**0.06**	**0.05**
E9-D3	**Air**	**2015**	**0.01**	**0.01**	0.01	**0.07**	**0.06**
PF-1	Fencing	4/7/15	0.76	0.74	0.76	0.68	0.63
DU-Back	Dune	4/7/15	0.00	0.00	0.00	0.01	0.01
PS-Back	Fencing	4/7/15	0.38	0.37	0.38	0.75	0.73
SF-1	Foam	4/7/15	0.92	0.91	0.92	0.90	0.88
PS-1	Fencing	4/7/15	0.00	0.00	0.00	ND	ND
SW-2	Seawater	6/20/16	1.00	1.00	1.00	1.00	1.00
SW-3	Seawater	6/20/16	1.00	1.00	1.00	1.00	1.00
PS-2	Fencing	6/20/16	0.19	0.19	0.68	0.15	0.08
PS-3	Fencing	6/20/16	0.08	0.08	0.13	0.10	0.09
E1-#1-4	**Air**	**6/16/16**	**0.00**	**0.00**	**0.72**	**0.10**	**0.06**
E1-#18-20	**Air**	**6/16/16**	**0.00**	**0.00**	**0.91**	**0.08**	**0.06**
E3-#8-11	**Air**	**6/16/16**	**0.00**	**0.00**	**0.96**	**0.35**	**0.15**
E3-#18-20	**Air**	**6/16/16**	**0.00**	**0.00**	**0.99**	**0.03**	**0.00**
E4-#1-3	**Air**	**6/13/16**	**0.00**	**0.00**	**0.95**	**0.12**	**0.04**
E4-#34-36	**Air**	**6/13/16**	**0.00**	**0.00**	**0.61**	**0.11**	**0.00**
E5-#1-3-Mesa2	**Air**	**6/13/16**	**0.00**	**0.00**	0.69	**0.06**	**0.03**
E5-#34-36	**Air**	**6/13/16**	**0.00**	**0.00**	**0.84**	**0.10**	**0.07**

Table 1. Sample descriptions and fraction (of 1) of total DNA sequence reads from each sample that were likely of marine origin, based on comparison to either only the seawater OTUs ("SW only") or those and database-derived sequences ("SW + DB"). "Singlets removed" refers to the same sample but only including sequences present two or more times. ND, not determined. The data shows that marine microbes make substantial contributions to EBAMs, as seen in the DNA recovery from EBAM filters (bolded).

OTU Name	Taxonomy					SUM OF EBAM READS	SUM OF SW READS	SUM OF DUNE READS
1116384	Proteobacteria	Betaproteobacteria	Burkholderiales	Comamonadaceae(100)	Pelomonas(97)	148872	0	0
513602	Proteobacteria	Gammaproteobacteria	Xanthomonadales	Xanthomonadaceae(100)	Dyella(67)	65515	0	15
1098473	Actinobacteria	Actinobacteria	Propionibacteriales	Propionibacteriaceae(100	Propionibacterium(100)	32639	1	349
562126	Proteobacteria	Alphaproteobacteria	Rhodobacterales	Rhodobacteraceae(100)	Ruegeria(83)	26722	0	0
891054	Proteobacteria	Gammaproteobacteria	Pseudomonadales	Moraxellaceae(100)	Acinetobacter(100)	15844	0	0
195676	**Bacteroidetes**	**Flavobacteriia**	**Flavobacteriales**	**Cryomorphaceae(100)**	**Fluviicola(81)**	**14553**	**1372**	**25**
548576	Proteobacteria	Gammaproteobacteria	Pseudomonadales	Moraxellaceae(100)	Psychrobacter(100)	11755	0	0
740871	**Proteobacteria**	**Alphaproteobacteria**	**Rhodobacterales**	**Rhodobacteraceae(100)**	**Paracoccus(56)**	**9823**	**7**	**0**
750018	**Proteobacteria**	**Gammaproteobacteria**	**Pseudomonadales**	**Pseudomonadaceae(100)**	**Pseudomonas(91) ***	**7884**	**2**	**1609**
4359693	Firmicutes	Bacilli	Bacillales	Alicyclobacillaceae(100)	Effusibacillus(100)	7210	0	0
79299	Proteobacteria	Gammaproteobacteria	Pseudomonadales	Moraxellaceae(100)	Psychrobacter(100)	7126	0	0
1009894	Proteobacteria	Gammaproteobacteria	Pseudomonadales	Moraxellaceae(100)	Acinetobacter(100)	6594	0	0
633252	Proteobacteria	Gammaproteobacteria	Pseudomonadales	Pseudomonadaceae(100)	Pseudomonas(98)	6295	0	1
582075	Proteobacteria	Alphaproteobacteria	Rhizobiales	Rhizobiales_Incertae_Sedi	Phreatobacter(80)	6149	0	2
927367	Actinobacteria	Thermoleophilia	Solirubrobacterales	FFCH11085(100)	FFCH11085_ge(100)*	5376	0	2191
1099674	Firmicutes	Bacilli	Bacillales	Staphylococcaceae(100)	Staphylococcus(100)	5189	0	0
894969	Firmicutes	Bacilli	Bacillales	Family_XI(100)	Gemella(100)	4975	0	0
131115	Proteobacteria	Gammaproteobacteria	Xanthomonadales	Xanthomonadaceae(100)	Rhodanobacter(41)	4679	0	0
New.ReferenceOTU263	Proteobacteria	Gammaproteobacteria	Xanthomonadales	Xanthomonadaceae(100)	Dyella(49)	3961	0	0
549538	Proteobacteria	Gammaproteobacteria	Xanthomonadales	Xanthomonadaceae(100)	Rhodanobacter(46)	3663	0	0
240252	Proteobacteria	Alphaproteobacteria	Rhodospirillales	Acetobacteraceae(100)	Acidocella(100)	3549	0	0
804483	**Proteobacteria**	**Alphaproteobacteria**	**Rhodobacterales**	**Rhodobacteraceae(100)**	**Amylibacter(99)**	**3493**	**9546**	**0**
New.ReferenceOTU149	Proteobacteria	Alphaproteobacteria	Sphingomonadales	Sphingomonadaceae(74)	Novosphingobium(69)	3429	0	32
1088265	Actinobacteria	Actinobacteria	Propionibacteriales	Propionibacteriaceae(100	Propionibacterium(100)	3289	1	30
1052559	Proteobacteria	Alphaproteobacteria	Sphingomonadales	Sphingomonadaceae(76)	Sphingomonas(69)	3254	0	4

*Potential Dune Source to EBAMS

Table 2. Top 25 most abundant bacterial OTUs in EBAM samples (with all EBAM samples combined). Bold shows predicted marine bacteria (based on presence of those OTUs in the seawater samples), with the exception of *Pseudomonas*, which may be due to dune input. Dunes may be contributing some bacteria such as FFCH11085 given the abundance of this sequence in the dune reads.

OTU	Taxonomy	SUM OF SW READS	SUM OF EBAM READS	SUM OF DUNE READS	Likely marine	Land Plant	Fungi	Unknown	Topblast hit	%ident	Topblasthit
New.ReferenceOTU163	Diatomea(100);Bacillariophytina(100);	0	339703	0	yes				KY852256.1	100	Chaetoceros calcitrans strain CCMP1315
New.ReferenceOTU26	EDiatomea(100);Bacillariophytina(100);	0	77758	0	yes				KU900218.1	100	Thalassiosira pseudonana strain CCAP 1085/12
New.ReferenceOTU129	Dikarya(100);Ascomycota(100);	0	36026	20			yes*		KR336841.1	100	Candida austromarina
New.ReferenceOTU1	Eumetazoa(43);Bilateria(43);	0	22363	0				yes	FJ459746.1	90 *	Gregarina kingi
New.ReferenceOTU108	Diatomea(100);Bacillariophytina(100);	0	8376	0	yes				KY852256.1	95	Chaetoceros calcitrans strain CCMP1315
New.ReferenceOTU91	Phragmoplastophyta(100);Streptophyta(100);	0	7114	42		yes			AJ272181.1	99	Triticum aestivum
New.ReferenceOTU117	Dikarya(95);Basidiomycota(95);	0	6724	0			yes		LT603011.1	97	Hyphoderma orphanellum
New.ReferenceOTU79	Phragmoplastophyta(100);Streptophyta(100);	0	6197	0		yes			KT459214.1	98	Vicia villosa (Vetch)
New.ReferenceOTU128	Eumetazoa(94);Bilateria(94);	0	5930	0				yes	FJ808261.1	93	Nepalomyia sp. 3 SNK-2009
New.ReferenceOTU24	Dikarya(77);Basidiomycota(77);	0	5844	0			yes		MF112031.1	99	Sporobolomyces roseus
New.ReferenceOTU158	unclassified;unclassified;	0	4951	0				yes	JQ245081.1	95	Centroheliozoa sp. ATCC 50535
New.ReferenceOTU148	Diatomea(16);ME-Euk-FW10(16);	0	3804	0	yes				KY054619.1	100	Uncultured eukaryote clone E035
New.ReferenceOTU99	Dinophyceae(51);SGYI905(22);	0	3743	0	yes				AB686255.1	95	Lepidodinium sp. MH 360
New.ReferenceOTU58	Chrysophyceae(27);P34.45(20);	0	3426	0	yes				L31799.1	85 *	Gregarina caledia
New.ReferenceOTU140	Eumetazoa(96);Bilateria(96);	1	3316	0	yes				GU175705.2	99	Dolioletta gegenbauri (marine tunicate)
New.ReferenceOTU176	**Diatomea(100);Bacillariophytina(100);**	**155**	**3231**	**0**	**yes**				**DQ514870.1**	**98**	Thalassiosira oestrupii var. venrickae strain CC03-15
New.ReferenceOTU65	Dikarya(100);Ascomycota(100);	0	3027	0			yes		KU058168.1	100	Saccharomyces cerevisiae strain JCABSC23
New.ReferenceOTU75	**Diatomea(100);ME-Euk-FW10(64);**	**65**	**2979**	**0**	**yes**				**KX229690.1**	**99**	Pseudo-nitzschia fraudulenta strain UNC1413
New.ReferenceOTU20	Diatomea(97);Bacillariophytina(47);	0	2912	0	yes				FM877746.1	99	Diatom endosymbiont ex foraminifera MH-2008
New.ReferenceOTU110	Dikarya(98);Basidiomycota(98);	0	2800	0			yes		LT603002.1	**99**	Hyphodontia rimosissima
New.ReferenceOTU96	Rhodymeniophycidae(27);Melanthalia(10);	0	2754	0				yes	FJ459752.1	80 *	Leidyana erratica
New.ReferenceOTU40	Dikarya(100);Basidiomycota(100);	0	2566	0			yes		AY336784.1	**100**	Antrodia sitchensis strain HHB 5298SP
New.CleanUp.ReferenceOTU2271	Conoidasida(94);Gregarinasina(77);	0	2561	0				yes	FJ459755.1	99	Paraschneideria metamorphosa
New.ReferenceOTU145	Eumetazoa(100);Bilateria(100);	0	2287	0				yes	KT946005.1	**100**	Helicoverpa zea (moth)
New.ReferenceOTU151	Colpodellida(23);Voromonas(22);	0	1956	0				yes	AJ697751.1	93	Cryptosporidium struthionis
										*Poor coverage	
*marine fungus											

Table 3. Top 25 most abundant eukaryotic OTUs found in EBAM samples. Bold shows taxa predicted by presence in seawater sample. Other marine taxa were found by taxonomic knowledge and BLAST annotation. *Triticum aestivum,* common wheat, may be coming from cereal straw bales used for erosion control.

OTU	Taxonomy	SUM OF SW READS	SUM OF EBAM READS	SUM OF DUNE READS	Top Blast Accession	%identity	Name
New.ReferenceOTU107	Eumetazoa(100);Bilateria(100);	0	0	24638	KP325041.1	97	Micropsammus sp. ARP-2015 (mite)
New.ReferenceOTU49	unclassified;unclassified;	0	0	10750	JQ245081.1	98	Centroheliozoa sp. ATCC 50535
New.ReferenceOTU22	Phragmoplastophyta(100);Streptophyta(100);	0	0	6580	KT179677.1	98	Helianthus pauciflorus subsp. subrhomboideus
New.ReferenceOTU51	Trebouxiophyceae(100);Trebouxiales(90);	0	5	6450	KM056291.1	99	Trebouxia sp. 142 (microalga)
New.ReferenceOTU86	Thecofilosea(100);Cryomonadida(100);	0	0	5667	KY905096.1	95	Rhogostoma cylindrica isolate KD1020
New.ReferenceOTU153	Trebouxiophyceae(93);Chlorellales(49);	0	0	3300	JX169829.1	99	Apatococcus lobatus strain SAG 2151 (microalga)
New.ReferenceOTU55	Chytridiomycota(99);Incertae_Sedis(99);	0	0	2682	AH009023.2	98	Geranomyces variabilis strain BK91-11
New.ReferenceOTU162	Chrysophyceae(24);Incertae_Sedis(19);	0	0	2211	KU587705.1	98	Cyphobasidium hypogymniicola voucher S-F264671
New.ReferenceOTU123	Phragmoplastophyta(100);Streptophyta(100);	0	0	1634	AF051798.1	99	Pinus elliottii (slash pine)
New.ReferenceOTU125	Eumetazoa(92);Bilateria(92);	0	0	1495	KJ636268.1	99	Meloidogyne hapla strain MeloHap11 (nematode)

Table 4. The most abundant eukaryotic OTUs in four dune sand samples. These OTUs were not typically found on EBAMs. A few OTUs such as the microalgae appear to be microbial residents in the sand while others are from nearby plants.