



**2005 Urban Watch-First Flush
Storm Drain Monitoring Program
in the unincorporated area of
Live Oak
Santa Cruz County, California**

June 28 – October 27, 2005

A Program Administered by the Coastal Watershed Council:
Tamara Doan, Director of Programs &
Emily Bucher, Volunteer Coordinator

Report Prepared by:
Tamara Doan & Emily Bucher

For:

**The County of Santa Cruz - Public Works Department &
the NPDES Phase II Storm Water Management Program**
Rachel Fatoohi, Senior Civil Engineer &
Alyson Tom, Associate Civil Engineer

Coastal Watershed Council
PO Box 1459, Santa Cruz, CA 95060
831-464-9200; 831-464-9214 FAX
www.coastal-watershed.org
volunteer@coastalws.org

Live Oak Urban Watch Monitoring Program

PROGRAM OVERVIEW

The Live Oak Urban Watch-First Flush storm drain monitoring program was initiated by the Coastal Watershed Council (CWC) in April 2005 on behalf of the County of Santa Cruz, NPDES Phase II Storm Water Management Program, the Central Coast Regional Water Quality Control Board, and funded under the County's Proposition 13 - Coastal Non-Point Source Pollution Control Grant (Agreement: 03-221-553-0).

The Urban Watch Program started in 1997 as a joint effort between the Coastal Watershed Council, the City of Monterey, and the Monterey Bay National Marine Sanctuary. The "First Flush" event first took place in 2000, and the program has expanded regionally to include eight programs across the Monterey Bay in 2005. The goals of the Urban Watch-First Flush Program are twofold: First, to serve as a tool for education and outreach to the community regarding the impacts that the citizens have on local water quality thru urban run-off; and secondly, to collect important water quality data to support environmental management decisions at the local and state levels. These goals are achieved through the participation of trained volunteers who monitor dry-season storm drain discharges at selected outflow areas throughout the Live Oak area. Urban Watch monitoring typically occurs twice weekly from June through approximately mid-November, ending with the first significant rain.

The Urban Watch-First Flush Program culminates with the "First Flush" monitoring event wherein volunteers monitor during the first significant rain of the wet season at the same Urban Watch program storm drains. This rain event washes the streets and 'flushes' the gutters and storm drains of collected materials and pollutants that have accumulated throughout the dry-season. Volunteers take in-field measurements and collect samples during the rain event. These samples are then sent to a professional lab where analysis for trace metals, nutrients, and pathogens, are performed. Although the First Flush event will be mentioned in passing throughout this report, complete Annual First Flush event summary reports are produced by our program partner, the Monterey Bay Sanctuary Citizen Watershed Monitoring Network (Network), and reports from every year's event can be downloaded from their web site at: <http://www.mbnms.nos.noaa.gov/monitoringnetwork/events.html>

PROGRAM DESIGN

Equipment & Parameters

CWC's Urban Watch monitoring kit has been designed to provide a method for volunteers to monitor dry-season storm drain discharges and identify common urban pollutants and contaminants within the study area. The Urban Watch Program utilizes a stormdrain water quality monitoring kit manufactured by the LaMotte Company (SSDK 7446) and designed in association with the City of Ft. Worth, Texas. This kit was developed according to National Pollutant Discharge Elimination System (NPDES) Phase I dry weather monitoring requirements and is designed to detect illegal storm drain connections and discharges. To this pre-assembled kit CWC has added to the base kit equipment such as thermometers, two Oakton 'ECTestr' conductivity meters (1-high, 1-low range) and replaced the Oakton 'pHTestr' meter with pH strips for ease of use by volunteers, as well, two Hanna Instruments ion meters were added to the Live Oak kit; a Nitrate-Nitrogen meter (HI 93707) was added in July, and an Ortho-phosphate meter (HI93713) was in September.

The parameters volunteers monitored include: detergent surfactants, phenols, nitrate-nitrogen, ortho-phosphate, ammonia-nitrogen, copper (total), chlorine (total), pH, conductivity, air and water temperature, sample water odor and color (Table 1). Volunteers also noted if there was oil sheen, sewage, trash, and surface scum, present on the water, or at the storm drain station. They also determined sample turbidity using a "Low-Medium-High" designation. As well, volunteers made other notable observations of changes to the station environment, including signs of recent 'pollution' activities or sources, and wildlife observations.

Table 1: Water Quality Parameters for the Urban Watch Monitoring Program.

Parameter	Possible Sources	Associated Problems	Method/Accuracy
Temperature: Air & Water	Illegal discharges	Affects rates of chemical and biochemical reactions in water.	Method – Digital thermometer Accuracy \pm 1% full scale Or Bulb Thermometer (Spirit) -5.0 – 55 oC
pH	Aerosols and dust in air, mineral substances, sewer overflows, animal wastes, pesticides & fertilizers, photosynthesis	Interferes with fish and other aquatic life	Method – MacHery-Nagel pH-Fix 4.5-10.0 color-fixed indicator strips Accuracy \pm 0.25 units Min detection: 4.5
Detergent surfactants	Illegal or unintended discharges, car washing, cleaning of screens and grills, leaking sanitary sewers	Can be toxic to many aquatic insects, plants, and fish; can lower dissolved oxygen available to aquatic life	Method – solvent extraction/ bromphenal blue indicator Accuracy \pm 0.1 ppm Min detection: >0.1 ppm
Phenols	Disinfectants, toothpaste, mouthwash from domestic water	Interferes with fish and other aquatic life	Method – Aminoantipyrine Octa-Slide Comparator against color standard. Accuracy \pm 10% Min detection: 0.5 ppm
Ortho-phosphate	Illegal or unintended discharges, car washing, cleaning of screens and grills, leaking sanitary sewers, fertilizers	Can be toxic to many aquatic insects, plants, and fish; can lower dissolved oxygen available to aquatic life	Hanna Portable Phosphate Meter (Low Range-HI 93713) Method – Ascorbic acid Accuracy 0.04mg/L; \pm 4% Range 0.00 to 2.50 mg/L; 0.01 mg/L
Nitrate-Nitrogen	From wastewater and sewer overflows and non-point sources such as agriculture and urban runoff; including fertilizers, confined livestock/animal wastes, septic systems and sewage treatment systems.	Toxic to aquatic and human life. Concentrations stimulate growth of algae and aquatic plants which can negatively affect creek health.	Hanna Portable Nitrate Meter (High Range-HI 93728) Method – Cadmium reduction Accuracy \pm 0.5 mg/L, \pm 10% Range 0.00 to 30.0 mg/L; 0.1 mg/L
Copper	Illegal discharges into the storm drain system; also can occur naturally in surface waters.	Concentrations over 0.025 parts per million are toxic to most freshwater fish.	Method – Diethyldithiocarbamate Octa-Slide Comparator against color standard. Accuracy \pm 10% Min detection: >0.0 ppm
Chlorine	Illegal or unintended connections to a Storm drain or draining of a swimming pool.	Toxic to aquatic life, can create a "sterile" environment.	Method – DPD Octa-Slide Comparator against color standard. Accuracy \pm 10% Min detection: >0.2 ppm
Ammonia-Nitrogen	Illegal connections to storm drain systems, poorly functioning septic systems, wildlife.	At certain concentrations can be toxic to aquatic organisms.	LaMotte Code 5864 Method – Octa-Slide Comparator against color standard. Min detection: >0.1 ppm
Conductivity	Discharges high in salts and minerals or metals, water moving through local geology.	Possible agricultural, industrial or municipal wastewater runoff.	Method – Electrode probe module. Accuracy \pm 1% Min detection: 10 mS or 10 μ S
Turbidity	Microorganisms, sediment, erosion.	Interferes with fish and other aquatic life.	Method – Visual Octa-Slide Viewer Compare to a 5 step "Low/Med/High" turbidity standard slide bar
Color	Dyes or chemicals	Interferes with aquatic Insects	Method – Visual Borger Color System
Odor	Illegal discharges or product of decomposition; "clean" drainage water should have no distinctive odor	Can indicate presence of contaminants.	Method – Scent
Oil sheen	Hydrocarbons such as oil, gasoline, and grease; leaking underground petroleum storage tanks	Toxic to aquatic organisms.	Method – Visual
Trash, sewage, scum	Illegal discharges or illegal dumping	Interferes with fish and other aquatic life.	Method - Visual

Units: ppm – parts per million; mg/L – milli grams per liter; mS – milli Siemens; μ S – micro Siemens

Monitoring Locations

The Coastal Watershed Council and a representative of the County of Santa Cruz Public Works Department chose seven sampling stations based on drainage basin and safe access for volunteers (Figure 1). The monitoring stations established for this program were referred to as: (1) **Lincoln Beach-13th Street**, open channel drainage area from 13th Street; (2) **Lincoln Beach-14th Street**, double-ended black plastic culvert that drains 14th street; (3) **Blackpoint Lane**, an open channel drainage at base of the DEVCON Bank parking lot; (4) **Shearwater**, concrete culvert outfall located along the west end of the Shearwater apartment complex on Portola Ave; (5) **30th Avenue**, 60" concrete culvert channeling Moran Creek to the east of the 30th Avenue overpass; (6) **"Privates"**, two 50" concrete culvert outfalls on the cliff to the east of the stairs at "Privates Beach"; and (7) **Simpkin's**, concrete culvert is to the east of Simpkin's Swim Center off 17th Ave; southeast of the swimming pool area and community building. Table 2 shows the approximate drainage area, type of drain and discharge area of the Live Oak stations.

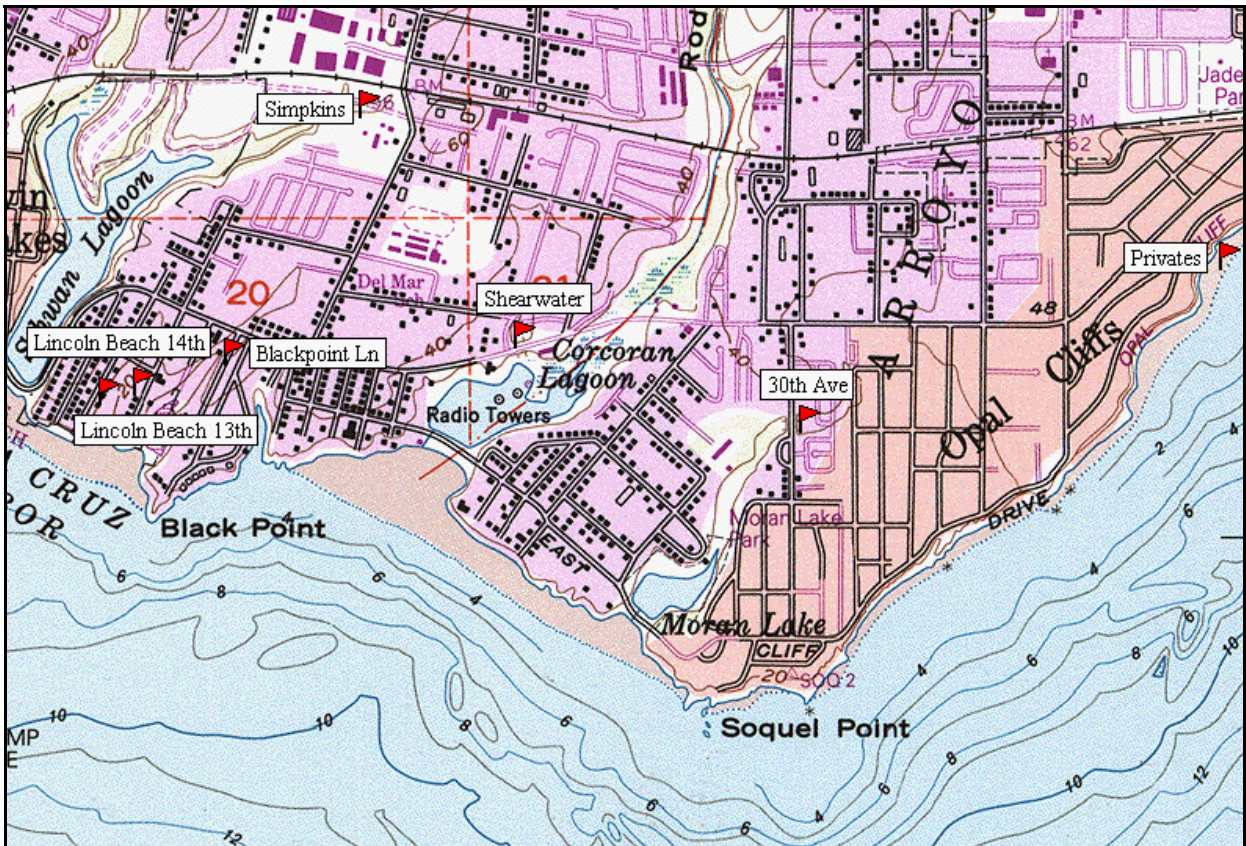


Figure 1: Monitoring station locations for the Live Oak Urban Watch Program, Santa Cruz County, California (TOPO! 1997).

Table 2: Drainage descriptions of the monitoring stations for the 2005 Urban Watch Program in the unincorporated area of Live Oak, Santa Cruz County.

Station Name	Station ID	Drainage Area (acres)	Land use (Approximate)	Drainage Type (Collection point)	Discharges to:
Lincoln-13th	LOSD-01	15	90% residential: 10% Commercial	Surface drainage; open channel, end of system.	Ocean
Lincoln-14th	LOSD-02	3	95% residential: 5% Commercial	Corrugated plastic pipe; end of pipe, end of system.	Ocean
Blackpoint	LOSD-03	37	70% residential: 30% Commercial	Surface drainage, passing thru concrete culvert; end of culvert, <1000' from end of system.	Ocean
Shearwater	LOSD-04	69	100% residential	Corrugated metal pipe/concrete pipe join together; collect 'joint' flows below join, <500' from end of system.	Lagoon
30th Ave	LOSD-05	390	40% residential: 60% Commercial	Surface drainage, passing thru concrete culvert; end of culvert, <500' from end of system.	Lake
Privates	LOSD-06	50	95% residential: 5% Commercial	Corrugated plastic pipe discharging to a cement box culvert w/dissipater and drainage holes; end of culvert, end of system.	Ocean
Simpkin's	LOSD-07	110	50% residential: 50% Commercial	Surface drainage, passing thru concrete culvert; end of culvert mid-system.	Ocean

Drainage area and land use information supplied by the County of Santa Cruz Public Works Department, 2006.

VOLUNTEER TRAINING

Volunteer preparation

All Urban Watch and First Flush Program volunteers attended one four-hour “classroom” training, and received a minimum of four hours “in-field” training. Volunteer training sessions cover pertinent topics including explanation of parameters to be monitored, monitoring protocols to be used, in-field and chemical safety, and a briefing on safe public encounters.

Tamara Doan of the Coastal Watershed Council (CWC) and Bridget Hoover of the Monterey Bay Sanctuary Citizen Monitoring Network (Network) provided a four-hour hands-on training for both the Urban Watch and First Flush programs. In each instance, volunteers are presented with program materials which included: detailing station locations, explanations of monitoring equipment and materials, procedural instructions and test protocols, as well as ancillary information on the subject of urban pollutants. Topics emphasized include monitoring concepts and clean sample collection procedures, test protocols, use of kits in the field, and safety procedures. In 2005 this included the NOAA Hazard Communication training (29 CFR 1910.1200). Training for the First Flush event was identical in format, and also included an in-field “dry run” training at each storm drain.

Volunteer monitoring

The trained Urban Watch volunteers were then scheduled into teams for monitoring over the duration of the program. A CWC staff person or trained “team leader” accompanied each Urban Watch volunteers in the field for each station visit. Volunteers conducted the Urban Watch monitoring at all stations twice a week throughout the monitoring period June to November 2005.

In the Live Oak program 18 volunteers were trained and divided into four teams of between 3-5 members each, and each team was assigned one week per month to monitor. Field observations and sample collection were completed by each team twice during their assigned week, resulting in twice weekly monitoring for the program. Randomized sample collection was achieved by incorporating a flexible monitoring schedule with volunteers; where the week of the month was assigned to a team, but day of

week and time of day was left up to the monitoring teams based on the volunteer availability. Volunteers were required to sample during daylight hours, and did so both on weekdays and weekends. A monitoring event for a team consisted of two field visits to all sites within the 7-day period Monday-Sunday. One data sheet was completed at each station for each of the two visits whether or not there was flow detected from the storm drain outfall on that occasion.

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

In 2004 CWC and the Network jointly submitted a Quality Assurance Project Plan (QAPP) for the 'Monterey Bay Regional Urban Watch-First Flush Program'. This document was approved by the Quality Assurance Officer for the Central Coast Regional Water Quality Control Board on October 8, 2004, and will continue to be in effect as long as the program is maintained by CWC and the Network (QAPP and monitoring protocols are available upon request). The purpose of the QAPP is to outline the technical aspects of the monitoring program relating to the quality of data assured by the implementation of the program as described in the document, including but not limited to; required training, sampling methods and procedures, analytical methods, equipment maintenance, documentation protocols, and various quality control requirements.

A sample of the Quality Assurance/Quality Control (QA/QC) program requirements included the QAPP:

Training (staff and volunteers)

- Monitoring concepts, parameter information
- Sampling methods: Conducting a station visit; Water sample collection; Monitoring equipment & protocols
- Use of data sheets and chain of custody documents
- Safety; chemical, in-field, & public interaction

Equipment maintenance & Programmatic QA/QC Procedures (staff)

- Regular inspection of monitoring equipment and program "kits"
- Periodic calibration of test equipment (calibration records are available)
- Monitoring of reagent stores, chemical expiration dates, and waste management.
- Completion of a Standard Operation Procedure for volunteers to use in the field while monitoring.
- Use of regulated monitoring regime (volunteer schedule)
- Continued supervision until the trainer was confident in the volunteers' sampling and analysis skills.

Data Quality Management Procedures (staff)

- Training in CWC's Citizen Water Quality MS Access database, data entry
- Use of Instrument ID numbers to track equipment used by teams
- Use of Station ID numbers to track monitoring locations
- Maintaining records of equipment calibration
- Periodic review of data entry (field data sheets and lab reports) to assure consistent data entry.
- Processing and analysis of data for report
- Storage of all original datasheets on the CWC premises for a minimum of 3 years

MONITORING RESULTS

The parameters listed in the following sections were analyzed in the field using the Urban Watch monitoring kit as described above or in the Santa Cruz County Department of Environmental Health Water Quality Laboratory. Over the period of June 28, through October 27, 2005, monitoring took place at stations 1-6, 37 times. The Simpkin's location, station 7, was added to the program on July 9, 2005, after safe access to the station was secured, and was monitored 35 times over the course of the program. Therefore a total of 259 individual monitoring events occurred during the program. Water Samples were drawn once a month for four months, July and October (at stations with 'flowing' water at the time of the visit), and were taken to the County's lab for bacteria and nutrient analysis.

Volunteer availability and other technical factors (such as equipment availability or breakage and weather conditions) were taken into account throughout the program resulting in not every parameter being tested/observed for every station visit. "Frequency" of detection is therefore the relationship of the number of times the parameter was recorded as other than normal or non-detect, out of the total number of times a measurement or observation for that parameter was completed throughout the program. Please see the Appendix for Summary Tables 1-6: Tables 1-4 provide monitoring result of the parameters monitored, showing averages, minimum-maximum values, and frequency of detection; Table 5 presents the lab analysis results; Table 6 presents a consolidated record of the data collected in the field in tabular form by station.

The Water Quality Objectives (WQO) are listed for each parameter that has an approved 'criteria' or range; we have noted the origin of each determination. These criteria originate from accepted sources such as the United States Environmental Protection Agency (US EPA), the State Water Resources Control Board's "California Ocean Plan", the Central Coast Regional Water Quality Control Board's (CCRWQCB) "Basin Plan", and the California Department of Fish and Game's (CDFG) "Salmonid Recovery Plan" (used predominantly where discharges flow directly to a salmonid stream).

The Monterey Bay Regional Urban Watch-First Flush Program operates in the 'Central Coast Region' and we therefore also recognize the CCRWQCB's 'Ambient Monitoring Program' which has also set criteria for many parameters based on region specific conditions or concerns in the form of "Attention levels". These attention levels are non-regulatory in nature, and are frequently lower than the regulatory criteria. Detections of pollutants or conditions at the "Attention level" are indicators of levels of a constituent where both human and wildlife health may be compromised and usually warrant further investigation. CWC refers to both the regulator and non-regulatory values in this report. For the purposes of this program; a 'detection' is any value greater than the lowest identified WQO criteria. In the case of parameters without criteria, such as Detergent surfactants or Phenols (man made chemical substances), then it is the minimum detection level of the test kit or tool. As well, pH values out of the normal range (6.5-8.0), or water temperatures above 26°C are also identified as a 'detection' of unsatisfactory water quality conditions.

Of the seven stations monitored throughout the duration of the program, four stations consistently exhibited no flow conditions. Therefore, the following results reflect only measurements taken at these three sampling stations. Flows were detected regularly at the Simpkin's and 30th Ave. stations, and flowing water was collected and analyzed two times from Blackpoint Lane.

I. Quantitative Parameters

(In-field chemical kit/meter analysis)

Detergent Surfactants

WQO: None.

Surfactants and detergents are common contaminants of surface water due to their large consumption for use in every type of washing and cleaning operation. Surfactants constitute the most important group of detergent components as they are water-soluble surface-active agents.¹ Detergent surfactants were developed in response to a shortage of animal and vegetable fats and oils during World War I and World War II. In addition, a substance that was resistant to hard water was needed to make cleaning more effective. At that time, petroleum was found to be a plentiful source for the manufacture of these surfactants. Modern detergents contain more than surfactants. Cleaning products may also contain enzymes to degrade protein-based stains, bleaches to de-color stains and add power to cleaning agents, and blue dyes to counter yellowing. Detergent surfactants are made from a variety of petrochemicals (derived from petroleum) and/or oleochemicals (derived from fats and oils).² The presence of detergent surfactants in a stormdrain system is a strong indicator of run-off or effluent discharges

There were 60 samples tested for detergent from the three sampling stations. Detergent surfactants were only detected at the Simpkin's sampling station during the course of the monitoring program. Detergent surfactants were detected in 7 of 26 samples (27%), with the highest detection of 1.2 ppm on July 10, 2005 and a median value 0.1 ppm. The range of detection for Detergent surfactants for all three stations was between 0.1 ppm and 1.2 ppm.

Phenols

WQO: None.

Phenol is a manufactured substance. It is a colorless-to-white solid when pure. The commercial product is a liquid. It has sickeningly sweet and tarry odor. You can taste and smell it at levels lower than those that are associated with harmful effects. Phenol evaporates more slowly than water, and a moderate amount can form a solution with water. Phenol can catch fire. Phenol is used primarily in the formation of phenolic resins. It is also used in the manufacture of nylon and other synthetic fibers. It is also used in slimicides (chemicals that kill bacteria and fungi in slimes), as a disinfectant, as an antiseptic, and in medicinal preparations, such as mouthwash and sore throat lozenges. You may be exposed to phenol if you work with or manufacture it.

You may be exposed to very low levels in your home because it is found in a number of products, including some medicines, lotions, and ointments. Low levels of phenol are found in some foods, including smoked summer sausage, fried chicken, mountain cheese, and some species of fish. Phenol enters the lungs when you inhale tobacco smoke and it can be present in low levels in air and drinking water.³ The presence of phenols in a stormdrain system is a strong indicator of run-off or effluent discharges.

There were 59 samples were tested for Phenols; however no phenols were detected during the monitoring period.

Nitrate Nitrogen (NO₃-N)

WQO: CCRWQCB CCAMP Attention Level >2.25 mg/L (ppm)

Nitrogen is one of the most abundant elements. About 80 percent of the air we breathe is nitrogen. It is found. Inorganic nitrogen may exist in the free state as a gas N₂, or as nitrate NO₃, nitrite NO₂, and ammonia NH₃. Organic nitrogen is found in the cells of all living things as a major component of proteins and is continually recycled by plants and animals. Nitrogen is a nutrient that occurs naturally in streams and is essential for plants and animals in an aquatic ecosystem. Problems occur when large amounts

¹ Sigma-Aldrich Co. http://www.sigmaaldrich.com/Brands/Fluka_Riedel_Home/Bioscience/BioChemika_Ultra/Detergents_Surfactants.html

² Soap and Detergent Association <http://www.sdahq.org/sdalatest/html/soapchemistry2.htm>

³ The Agency for Toxic Substances and Disease Registry (ATSDR), <http://www.atsdr.cdc.gov/tfacts115.html>

nitrogen are introduced into the stream ecosystem and can cause excessive algal growth depleting the available oxygen in the stream that fish and other aquatic organisms depend upon.

The term nitrate nitrogen (NO_3^-) is used to refer to the nitrogen present in the nitrate ion. This nomenclature is used to differentiate nitrate nitrogen from nitrogen in the form of ammonia (ammonia nitrogen, NH_3), from nitrogen in the form of nitrite (nitrite nitrogen, NO_2^-). Nitrate nitrogen is a commonly used lawn and agricultural fertilizer, and nitrate nitrogen can result from the seepage of water through soil containing nitrate-bearing minerals. It may also occur as the result of using certain fertilizers in the soil; however, nitrates are also one of the products of decomposition of animal and human wastes. Thus, the presence of nitrates in a water supply indicates possible pollution of the water.

In the process of decomposition, raw sewage undergoes a chemical change and among the end products is nitrate nitrogen. When nitrate nitrogen occurs in a fresh waterbody, it is considered evidence of pollution either from septic tank fields, cesspools or other sewage sources. Where a groundwater is known to contain little or no nitrate nitrogen naturally, the appearance of any significant increase is a probable indication of pollution. Common non-point sources for both nitrates and orthophosphate is weathering of natural soils and rocks, and surface runoff from urban and agricultural lands. During the course of the program nitrate-nitrogen was tested in the field using a Hannah Instruments ion specific meter and in the Laboratory. The following are results from the in-field tests with the ion meter.⁴

Nitrate nitrogen was measured 49 times. Nitrate nitrogen was detected 10 of 26 times at the 30th Ave station (38%), and 16 of 21 times at the Simpkin's station (76%). In only one sample did the result exceed the WQO when a detection of 2.4 ppm was measured at Simpkin's on July 29, 2005 (2%). The range of detection for nitrate nitrogen for all three stations was between 0.1 ppm to 2.4 ppm, median 0.8 ppm.

Ammonia Nitrogen ($\text{NH}_3\text{-N}$)

WQO: US EPA >0.025ppm

Ammonia is excreted by animals and produced during decomposition of plants and animals, thus returning nitrogen to the aquatic system. It is rapidly oxidized in natural water systems by special bacterial groups that produce the ions of nitrite (NO_2^-), nitrate (NO_3^-), and ammonia nitrogen ($\text{NH}_3\text{-N}$), which are then used by plants; therefore ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution. The un-ionized form of ammonia (NH_3) is the preferred nitrogen-containing nutrient for plant growth and is also one of the most important pollutants because it is relatively common but can be toxic in animals; causing lower reproduction and growth, or death to fish and other aquatic life.

Ammonia nitrogen ($\text{NH}_3\text{-N}$) is the nitrogen-ion concentration within the ammonia (NH_3) present in the sampled water. Ammonia nitrogen is present in various concentrations in many surface and ground water supplies and is sometimes accepted as chemical evidence of pollution when encountered in natural waters. During the course of the program ammonia-nitrogen was tested in the field using a Hannah Instruments ion specific meter and in the Laboratory. The following are results from the in-field tests with the ion meter.

Thirty-nine samples were tested for ammonia nitrogen, and of 30 of the 39 samples collected (77%) all values exceeded the WQO. The highest detected value across all stations was 2.17 ppm, at Simpkin's on July 29, 2005. Ammonia nitrogen was detected at the Simpkin's station in 14 of 16 samples (88%), at the 30th Ave. station in 14 of 21 samples (67%) and in both samples at Blackpoint Lane (100%). The range of detection for ammonia nitrogen for all three stations was from 0.05 ppm to 2.17 ppm, median 0.25 ppm.

Orthophosphate ($\text{PO}_4\text{-P}$)

WQO: CCRWQCB CCAMP Attention level of 0.12 mg/L orthophosphate as P

⁴ Kentucky "Water Watch": WWW.KYWATER.ORG; <http://www.state.ky.us/nrepc/water/wcpno.htm>

Phosphorus is another required macro-nutrient for green plants and animals. Phosphorus in elemental form is very toxic and is subject to bioaccumulation, however Phosphates (PO₄) are ions formed from this element. Phosphate ions exist in three forms: orthophosphate, metaphosphate (or polyphosphate) and organically bound phosphate. Each compound contains phosphorous in a different chemical formula. Rainfall can cause varying amounts of phosphates to wash from local soils into nearby waterways stimulating the growth of plankton and aquatic plants which provide food for fish. This increased growth may cause an increase in the fish population and improve the overall water quality, however if an excess of phosphate enters the waterway algae and aquatic plants could grow wildly, choking the waterway and using large amounts of available dissolved oxygen. A common source of phosphate is from urban and agricultural applications of fertilizers which bind to soils and erode during storm events adding considerable amounts of suspended phosphate to streams. Total suspended solids also are contributed to a river by soil erosion in response to lumbering and construction practices. The most important point source of phosphorus is municipal waste-water discharge, which discharges phosphate as orthophosphate and organic phosphorus.

Orthophosphates are produced by natural processes and are found in animal wastes. Orthophosphates are often a limited resource, especially in fresh water systems. When naturally occurring levels become elevated, algal blooms can occur which may lead to oxygen depletion and to fish kills. During the course of the program orthophosphate was tested in the field using a Hannah Instruments ion specific meter and in the Laboratory. The following are results from the in-field tests with the ion meter.

Orthophosphate was detected at low levels in 25 of the 25 samples tested (100%). Orthophosphate was detected at Blackpoint Lane the one time it was tested for, and at all 10 visits to Simpkin's, and all 10 visits to 30th Ave. (each 100%). Levels exceeded the WQO in 5 of 25 samples (20%); 2 of 14 samples at 30th Ave (14%) and 3 of 10 times at Simpkin's (20%). The highest detected value across all stations was 0.91 ppm; at 30th Ave. on October 1, 2005. The range of detection for orthophosphate for all three stations was between 0.04 ppm and 0.91 ppm, median 0.28 ppm.

Copper

WQO: CCRWQCB Basin Plan > 0.03 mg/L - Cold and Warm Water Fish Habitat.

Copper is a mineral element; however it is used in too many industrial applications to mention here. Specific to this program is the fact that surface runoff and stormwater flows pick up copper and zinc from brake and tire wear, nitrogen emitted from exhaust pipes, and other chemicals in vehicle wash wastewater.

There were 60 samples tested for copper; however no copper was detected during the monitoring period.

Chlorine

WQO: None (tap water is typically 2 mg/L).

Chlorine alone as Cl₂ is highly toxic, and it is often used as a disinfectant. In combination with a metal such as sodium it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life. High chloride levels can cause human illness and also can affect plant growth at levels in excess of 1000 mg/l. Taste threshold is about 250 mg/l for most people, however, calcium or magnesium chloride are not usually detected by taste until levels of 1000 mg/l are reached. Public drinking water standards require chloride levels not to exceed 250 mg/l.⁵ Very high detections in storm drain discharges could be an indicator of industrial waste waters, however low concentrations may indicate a drinking water discharge from a local source.

There were 60 samples tested for chlorine; however no chlorine was detected during the monitoring period.

⁵ Leonardo Tequila, A Training Course For Water Quality Experts, Italy:
http://www.italocorotondo.it/tequila/module2/pollution/forms_water_pollution.htm#Chlorides

II. Measured Values

(In-field measurement)

The following parameters were measured in the field during the 259 individual monitoring events. Please see the Appendix for Summary Tables 1-6: Tables 1-4 provide monitoring result of the parameters monitored, showing averages, minimum-maximum values, and frequency of detection; Table 5 presents the lab analysis results; Table 6 presents a consolidated record of the data collected in the field in tabular form by station.

Flow

WQO: None.

For the seven storm drains sampled, flow was detected during 66 of the 259 (25%) station visits. Flow was present at only three stations; 36 of 37 visits to 30th Ave. (97%), 28 of 34 visits to Simpkin's (82%) and 2 of 37 visits to Blackpoint Lane (5%). No flow was detected at any of the other four stations over the course of the program.

Air Temperature

WQO: None.

Air temperature was taken at 242 station visits. Air temperature ranges fell between: 11-22 °C at Lincoln Beach-13th; 10.5-22 °C at Lincoln Beach-14th; 11-22 °C at Blackpoint; 11.5-21 °C at Shearwater; 13-19 °C at 30th; 12-25 °C at Privates; and between 12-20.5 °C at Simpkin's (full shade at all times). The lowest recorded temperature was 11 °C at Lincoln Beach-13th and at Lincoln Beach-14th, on 10/26/05 (7:31 am) and at Blackpoint Lane on 10/15/05 (9:20 am). The highest recorded temperature was 25 °C at Privates on 6/28/05 (1:41pm).

Water Temperature

WQO: CCRWQCB Basin Plan > 26°C - Cold Water Fish Habitat.

Water temperature ranges fell between: 15-17 °C at Blackpoint (also low and high); 13-17 °C at 30th; and between 12-19 °C at Simpkin's (full shade at all times). The highest recorded temperature was measured at 19 °C on 7/10/05 (9:51 am), and the lowest was 12 °C on 10/21/05 (8:04 am), both at the Simpkin's station. No water temperatures were collected for Lincoln Beach-13th, Lincoln Beach-14th, Shearwater and Privates stations due to lack of flow.

Conductivity

WQO: None.

Electrical conductivity is a measure of a material's ability to conduct an electric current: when an electrical potential difference is placed across a conductor, its movable charges flow, giving rise to an electric current. Pure water is not a good conductor of electricity. Because the electrical current is transported by the ions in solution, the conductivity increases as the concentration of dissolved ions increases⁶ (ex.; salts and minerals). Conductivity measurements were taken with an Oakton ECTester low range meter (0-1990 µS) or with an Oakton ECTester high range meter (0-19.90 mS; 0-19,900 µS) to ensure no readings would be out of range.

Conductivity was measured in 97% of visits to 30th Ave averaging 660 µS, 80% of visits to Simpkin's averaging 660 µS, and 5% of visits to Blackpoint Lane averaging 605 µS. The highest conductivity recorded was 990 µS at Simpkin's, and the lowest was 470 µS at Blackpoint Lane. No conductivity measurements were collected for the Lincoln Beach-13th, Lincoln Beach-14th, Shearwater and Privates stations due to lack of flow.

⁶ Lenntech Water Treatment & Air Purification Holding B.V: <http://www.lenntech.com/water-conductivity.htm>

pH

WQO: <6.5 or >8 pH units.

pH is a measure of the acidic or basic (alkaline) nature of a solution. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom dwelling invertebrates. Typical rainwater has a pH of about 5 to 6. This means that it is naturally a neutral, slightly acidic liquid.⁷

Throughout the program pH values at all stations averaged 7.0 (Blackpoint Lane, 30th Ave. and Simpkin's). No pH readings were taken at Lincoln Beach-13th, Lincoln Beach-14th, Shearwater and Privates stations due to lack of flow.

III. Qualitative Parameters

(Visual observations)

Volunteers were asked to make 'presence or absence' observations of the following parameters. More detailed descriptions were noted on the data sheet, and can be provided upon request. These observations were recorded even if water samples were not collected. Please see the Appendix for Summary Tables 1-7: Tables 1-5 provide monitoring result of the parameters monitored, showing averages, minimum-maximum values, and frequency of detection; Table 6 presents a consolidated record of the data collected in the field in tabular form by station; Table 7 presents the lab analysis results.

Odors

No odors were noted in the water collected at any stations during the monitoring period.

Color

Volunteers matched water samples to a Borger Color System (BCS) booklet used to identify colors in nature. Sixty of the 66 samples tested for color were reported as colorless (91%). Of the remaining six samples, volunteers indicated the water samples to be a pale yellow, a pale tan, or drab grays or drab browns. Three samples were noted to have a 'color' at 30th Avenue, and two at Simpkins. Blackpoint Lane's samples were both noted as colorless. No water color samples were taken for Lincoln Beach-13th, Lincoln Beach-14th, Shearwater, or Privates stations due to lack of flow.

Oil sheen

An 'oil sheen' was observed once at Shearwater, once 30th Ave. (3%) and twice at Simpkin's (6%) during the 259 individual monitoring events. Volunteers were made aware of a similar looking 'natural' opalescent sheen, which is typical of a common iron oxidizing bacteria/fungus¹, and made an attempt to record only the petroleum or chemical 'sheen' and not the biological sheen.

Sewage

The observation 'sewage sighted or smelled' was found 10 times of the 259 site visits (4%), at least once at five of the stations; excluding Privates and Lincoln Beach-13th. In most instances a musky or sewer odor was 'smelled', on two occasions animal feces was observed (*and on one occasion a dead animal was found near the outfall): Lincoln-14th 7/19/2005 'smelled'; Blackpoint 7/20'smelled'; Shearwater 8/29 animal feces present, 6/30 animal feces present; 30th 9/29 'smelled', 9/9 'smelled', *8/15 dead rodent, 7/19 'smelled', 6/28 'smelled'; Simpkin's 10/21 'smelled', 8/23 'smelled', 7/14 'smelled'. The observation of sewage was reported 4 of 37 visits to 30th Ave. (11%) and 3 of 35 visits to Simpkin's (9%).

Surface scum

The observation 'surface scum' sighted indicates some type of 'froth' on the water's surface in or near the drain outfall; this 'scum' may be originate from any number of biological or human induced causes, and no specific information is gathered. Most, but not all, of these observations were typical of a common iron oxidizing bacteria/fungus which forms an oily or foamy 'rust' colored area at the water's margin (usually indicating that the stream is being recharged from a groundwater source, and these features are most

⁷ Lenntech Water Treatment & Air Purification Holding B.V: <http://www.lenntech.com/Water-Pollution-FAQ.htm>

commonly seen at seeps or springs⁸). The lowest frequency of surface scum was observed in 2 of 37 visits to Shearwater (5%). The highest frequency of surface sum was observed 25 of 35 visits to Simpkin's (71%), followed by 24 of 37 visits to 30th Ave. (65%). No surface scum was observed during the station visits to Lincoln Beach-13th, Lincoln Beach-14th, Blackpoint Lane, or Privates.

Trash

Trash was found at all stations except Lincoln Beach-13th and Privates during the monitoring season. The highest frequency was recorded at Simpkin's, where trash was detected during 51% of the visits. At 30th Ave., trash was recorded in 24% of station visits, Shearwater recorded trash on 22% of station visits, Blackpoint Lane trash was recorded in 11% of visits and at Lincoln Beach 14th, trash was recorded in 8% of the 37 station visits. The most common observations included paper (food wrappers and packaging), plastics, Styrofoam cigarette butts, and recyclables such as aluminum cans and glass bottles.

Turbidity

Turbidity was compared to a visual scale and was recorded consistently as "low" for Blackpoint Lane, 30th Ave. and Simpkin's stations during the monitoring period. No turbidity readings were taken for the Lincoln Beach-13th, Lincoln Beach-14th, Shearwater, or Privates stations due to lack of flow.

Day of Week/Time of Day

A total of 259 volunteer monitoring events occurred on Mondays (6), Tuesdays (5), Wednesdays (4), Thursdays (5), Fridays (7), Saturdays (4) and Sundays (4). The monitoring times varied; however, they were more frequently in the morning hours for the monitoring events.

IV. Additional Data

(Laboratory Analysis)

Laboratory Analysis

Field samples were collected for the four 'dry' months of the program from the three stations where water was found discharging at the time of the station visit:

Station:	7/27/05	8/29/05	9/29/05	10/26/05
Blackpoint Lane	Dry	Dry	Dry	X
30 th Ave	X	X	X	X
Simpkin's	X	X	Dry	X

Once the samples were collected, they were iced and delivered to Santa Cruz County Department of Environmental Health Services Water Quality Laboratory to be tested for bacteria (*E.coli*, total coliform), and nutrients (nitrate, orthophosphate, and ammonium nitrogen) (see Appendix Table 5 for all lab results).

Bacteria

***E. Coli* & Total Coliform**

CCRWQCB Basin Plan;

E. coli - WQO: No single sample shall exceed 400 MPN - Water Body Contact Recreation

Total coliform – WQO: No single sample shall exceed 10,000 MPN –Marine Water Contact Recreation

Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the fecal coliform bacteria, the most common member being *Escherichia coli* (*E. coli*). These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are a specific kind of fecal coliform bacteria that live in the intestines of warm blooded vertebrates.

⁸ "Fairfax County Stormwater Planning Division – Perennial Streams Field Identification Protocol", Fairfax County Public Works and Environmental Services Department
http://www.cblad.virginia.gov/docs/guidance/Perennial_Stream_Doc_Fairfax_NC/FairfaxMethod_May_03.pdf

Although these bacteria which naturally exist in human intestines are harmless and helpful in digestion, ingesting water tainted with *E. coli* can cause severe food poisoning or even death in humans. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water may have also been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. The test for total coliform is a measure all forms of coliform bacteria present in human and other mammal waste while the analysis for *E.coli* is to determine the presence of the more specific fecal coliforms.

Results from the laboratory analysis indicated the presence of *E.coli* and total coliform to be under the water quality objective in 9 of the 16 samples tested (56%).

The measurable values of *E.coli* ranged from 85 MPN/100ml (30th Ave on 9/29/05) to 5794 MPN/100ml (30th Ave on 7/27/05). Four of 8 samples analyzed in the Live Oak program exceeded the water quality objective of ≤ 400 MPN/100ml: Blackpoint Lane 10/26/2005, 5794 MPN/100ml; 30th Ave. 7/27, 5172 MPN/100ml; Simpkin's 7/27, 5172 MPN/100ml, and 8/29, 3873 MPN/100ml. The Simpkin's station had the highest frequency of detections, where *E.coli* was found in 2 of 3 samples collected; 67% of samples tested.

The measurable values for total coliform ranged from 1860 MPN/100ml (30th Ave on 9/29/05) to >24192 MPN/100ml (Simpkins and Blackpoint Lane), where 24192 equals the upper limit of the analysis performed. Five of the 8 samples analyzed in the Live Oak program exceeded the water quality objective of $\leq 10,000$ MPN/100ml. Simpkins had the highest frequency of detections in total coliform in the program, with every sample exceeding the test capacity of 24192 MPN/100ml, 100% of samples tested.

Nutrients

Nitrate-nitrogen, Orthophosphate & Ammonia-Nitrogen

WQO: CCRWQCB CCAMP;

Nitrate nitrogen - Attention Level >2.25 mg/L

Orthophosphate - Attention level > 0.37 mg/L

WQO: US EPA;

Ammonia-Nitrogen >0.025ppm

Also tested in the lab were the nutrients nitrate-nitrogen (NO₃-N), orthophosphate (PO₄-P), and ammonium-nitrogen (NO₃-N). The values for nitrate-nitrogen and orthophosphates were all found to be under their water quality objectives. Concentrations of ammonia nitrogen were found to be above the water quality objective of < 0.025 mg/L in 3 of 8 samples tested (38%); values ranging from 0.05 mg/L (Simpkin's, 10/26/05) to 0.82 mg/L (Blackpoint Lane, 10/26/05), and the other detection was 0.34 mg/L at 30th Ave., on 7/27/05.

V. First Flush Event

The First Flush monitoring event began on Tuesday, November 8, 2005 in the cities of Monterey, Pacific Grove, Capitola, Live Oak and Santa Cruz, and The cities of Scotts Valley and Seaside mobilized one day later on Wednesday, November 9, 2005. For the 2005 First Flush event, eleven trained volunteers participated in the collection of samples in Live Oak. The actual First Flush event began at approximately 4:00 am on the 8th and at 4:40pm on the 9th of November.

Storm drain outfalls were monitored for conductivity, water temperature, pH, transparency, and field samples were collected for analysis of nitrate, orthophosphates, zinc, copper, lead, total coliform, *E. coli.*, total dissolved solids, and total suspended solids. A separate report will be written for the 2005 First Flush monitoring event which will be available to the public and sent to local area governments and agencies.

The results of First Flush event are available by contacting Bridget Hoover, Coordinator of the Monterey Bay Sanctuary Citizen Watershed Monitoring Network at (831-883-9303). Previous First Flush reports can be downloaded from the Internet at: <http://www.mbnms.nos.noaa.gov/monitoringnetwork/events.html>

DISCUSSION

Of the five stations visited during the 2005 Urban Watch monitoring period, Blackpoint Lane, Simpkin's and 30th Avenue dispersed enough water flow to obtain water quality data. The remaining stations, Lincoln Beach-13th, Lincoln Beach-14th, Shearwater, and Privates, consistently exhibited no flow during each of the monitoring events.

Detergent surfactants were detected in 27% of samples tested, all of which were at Simpkin's. The highest recorded detection was 1.2 ppm on July 10, 2005. Nitrate-nitrogen was detected in one of 21 visits to Simpkin's. The nitrate-nitrogen detection was 2.4 ppm on July 29, 2005. Ammonia-nitrogen was detected in 77% of samples, the highest detection was 2.17 ppm at Simpkin's on July 29, 2005. The detections of ammonia-nitrogen were: Simpkin's in 88% of samples; 30th Avenue in 67% of samples; and Blackpoint Lane tested for ammonia-nitrogen two times and it was detected in both of those visits (100%). Orthophosphate was detected in 88% of all samples tested. The highest recorded detection was 0.91 ppm at 30th Avenue on October 1, 2005. Detections of orthophosphates were: Simpkin's in 100% of samples; 30th Avenue in 79% of samples; and Blackpoint Lane tested for orthophosphate one times and it was detected (100%). Nitrate-nitrogen was detected once in 21 samples tested (5%) at Simpkins. Results did not reveal any detection of phenols, copper or chlorine in the samples collected at all three stations with flow. Turbidity was consistently 'low' for all measurable stations during the 2005 program.

Simpkins station has shown to be the largest contributor of detergents, ammonia nitrogen, orthophosphates and nitrate nitrogen to the environment during the 2005 monitoring program.

From a qualitative observational standpoint, no distinct odor or intense color was detected in all 259 samples. Volunteers reported relatively low findings of the presence of oil sheen (2%), sewage (5%), surface scum (20%) and trash (16%) was noted.

CONCLUSIONS AND RECOMMENDATIONS

The 2005 Urban Watch season for the Unincorporated City of Live Oak was fortunate to have a total of 259 individual monitoring events to assess. Results from the data collected showed that detergents, ammonia nitrogen, and orthophosphates, are the most common contaminant entering storm drains within the study area, most specifically to Simpkin's station. No detectable amounts of chlorine, copper, phenols or nitrates were found in any of the samples collected at the three stations exhibiting flow. Surface scum was reported in 20% of station visits and consisted mostly of the presence of surface bubbles and foam, and iron oxidizing bacteria/fungus discharges. Additionally, there was a low frequency of oil sheen, sewage, and trash during the monitoring events.

Simpkins station was the largest contributor of contaminants during the monitoring season. We would recommend further investigation by the County of Santa Cruz and CWC staff to investigate the upstream influences at this station. As well, the highest percentages of trash were found at this location. The Urban Watch Program Director would like to coordinate with the County staff to strategically locate some new stations "up the watershed" for the Live Oak program, specifically in the Simpkin's area, so as to determine where these pollutants enter the system.

Furthermore, outreach should continue to be directed at businesses and increase in the neighborhoods and schools that drain into this part of the storm drain system. Other ideas may include working with local newspapers to publish weekly monitoring results from the Urban Watch program, working with the Chamber of Commerce or other business associations to promote clean water practices, and conducting a door-to-door survey/educational campaign in the Simpkin's storm drain 'drainage area'. Development of a Public Service Announcement for the local cable channel detailing information about storm water and urban runoff pollution is another possible avenue for outreach to a wider audience.

The data results continue to show the need for continued public outreach for urban runoff control within the city limits as well as in the neighborhoods that feed these drains. The continuation of this program in 2006 is highly recommended and will add to the data presented in this report and provide further information regarding the state of water health in Live Oak.

The First Flush event proved a useful event for data collection and showed a great need to do further monitoring in the systems now looked at with the Urban Watch monitoring. This program also is a great tool for volunteers to see what the storm drain system is meant to do.

In conclusion, the County of Santa Cruz is commended for its first year of the Live Oak Urban Watch monitoring program and is recommended to continue the program in 2006 to augment the data presented here. Recommendation for the 2006 program include: 1) assess upstream sources of illicit discharges and pollutant sources; 2) reassess the location of stations and parameters monitored based on the first year's findings, and support the investigation of additional parameters for study; and 3) continue outreach programs targeting local businesses, schools and residents to further reduce detergent concentrations and other sources of pollution from entering the Monterey Bay National Marine Sanctuary.

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