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***R**each**i**ng **O**ut to **C**ommunities and **K**ids with **S**cience in **S**an **F**rancisco*

Project Watershed:
Meaningful Watershed
Experience for Students

Jim Neiss
Claire Bailey
San Francisco State University

California B-WET Grantee Conference
May 16, 2008

Creating a New Generation of Earth and Environmental Scientists
The Preservation and Reclamation of our Environmental Systems is Best Left in the Hands of a Well-Informed and Diverse Group of Young Leaders and Scientists

Project Watershed

- Project Watershed is an advanced research module for San Francisco Unified School District High School Students.
- Partners: San Francisco Unified School District, and San Francisco Public Utilities Commission.
- Designed for 15 Students over 9 months (August – May).
- > 220 hours of instruction and field work.

Ethnic Background	Number		High School Class	Number
African American	2		Sophomore	1
Asian American	10		Junior	6
Hispanic/Latino	2		Senior	8
Pacific Islander	1			

Table 1: Student Demographics – Year 2006-2007

Project Watershed

Objectives:

(1) Improve high school students' abilities to develop, design, implement, and disseminate a year-long research investigation;

(2) Increase knowledge of the connection between urban water runoff and adjacent ecosystems such as the Gulf of Farallones National Marine Sanctuary and San Francisco Bay; and

(3) Link the history of environmental injustice in our students' home neighborhoods with environmental contaminants, and the adjacent ecology.

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Reaching Out to Communities and Kids with Science in San Francisco

Project Watershed

Program Components

1	2	3
Background Info **Research Design**	**Sample Collection** **Data Analysis**	**Results** **Dissemination** **AGU+9th Graders**
Aug - Sept	Oct - May	May + Dec

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Project Watershed

(1) Background Information and Research Design – Two Summer Weeks

Summer Classroom/Field Intensive (Class):

- Estuaries*
- Tides*
- Nonpoint Source Pollution*
- General Chemistry (Stoichiometry, Solutions, Balance Equations, etc)
- Chemistry of Wetlands (oxidation reduction chemistry)
- Watersheds
- Contaminant Review (pesticides, oil/gas, oil/grease, household chemicals, heavy metals, bacteria)
- Bioaccumulation/Biomagnification
- Data Collection/Analysis (EXCEL Skills)
- Topographic Maps/Compass/Orienteering
- Algebra Review
- Developing a Method
- History and Importance of Environmental Justice Movement
- Google Earth examination of the absence of wetlands around the Bay.

** NOAA Lesson Plan*

Project Watershed

1 Background Information and Research Design

Summer Classroom/Field Intensive (Field):

- Bair Island, wetland in Redwood City, California
  Oxidation-reduction chemistry/contaminant sequestration through senses – visual/smell).

- San Francisco Bay Research Cruise
  salinity and water temperatures in the Bay; links between pesticides used on land and the plankton cycle.

- Bay Model
  Conducted dye testing of 4 specific watershed run-off points studied in the classroom.

- "Toxic Tour" of Bayview Hunters Point District of San Francisco
  Led by Literacy for Environmental Justice (LEJ).

Project Watershed

1 Background Information and **Research Design**

Design Stormwater Collector for Storm Drains

Sample Collection Device Created by Students

Project Watershed

1 Background Information and **Research Design**

Develop Sampling Method

- Using a Barnant E/S Portable Pump, remove 1L stormwater from sample device.
  - Students problems solved and worked with limitations
    - No access to sampler, build up of sediment, trash, sample mixing

- Store samples at 3.5° C in 1 liter Nalgene bottles, label and catalog until processing

Develop Chemical Methods

- Oil and Grease: EPA Method 1664
- Toluene: EPA Method 8260B
- Gasoline Range Organics (TPH GRO's): EPA Method 8260B
- Nitrate: NitriVer 3 Method using a Hach Colorimeter DR/850
- Heavy Metals: Samples where filtered to 0.2 µm, acidified with concentrated HCl and analyzed on an Inductively Coupled Plasma - Optical Emission Spectrometer.

Project Watershed

1 **Background Information and Research Design**

Install Stormwater Catchment Devices 1-2 Blocks from each participants home. Assistance from SF-Public Utilities Commission.

Crane Lifting Drain Cover

Installed Sampler

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(1) Background Information and **Research Design**

- 11 Installations over 2 days.
- Two filled with concrete or sediment in first week.
- Two Students live in a high volume traffic area (no installation).

Sample Sites

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Project Watershed

Program Components

1. **Background Info Research Design** — Aug - Sept
2. **Sample Collection Data Analysis** — Oct - May
3. **Results Dissemination AGU+9th Graders** — May + Dec

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② **Sample Collection** and Data Analysis

1. Pump Sample
2. Fill Sampler with Clean Water
3. Extract Clean Water
4. Pump Clean Water through Tubing

Project Watershed

2 Sample Collection and **Data Analysis**

Samples Examined for:

- Oil and Grease: EPA Method 1664
- Toluene: EPA Method 8260B
- Gasoline Range Organics (TPH GRO's): EPA Method 8260B
- Nitrate: NitriVer 3 Method using a Hach Colorimeter DR/850
- Heavy Metals: Samples where filtered to 0.2 µm, acidified with concentrated HCl and analyzed on an Inductively Coupled Plasma - Optical Emission Spectrometer. (As, Zn, Hg, Cr, Cd)

All Data Graphed and Analyzed

- Few hits on TPH and Toluene
- No hits on Oil and Grease
- Nitrate ranged from 2.9 mg/L to 31 mg/L
- Heavy Metals – modeled per rain event

~~Dissolved Oxygen~~
~~Total Suspended Solids~~
~~Bacteria~~
~~pH~~

** See the students' poster during the B-WET poster session for results summary.*

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Reaching Out to Communities and Kids with Science in San Francisco

Project Watershed

Program Components

1
Background Info
Research Design
Aug - Sept

→

2
Sample Collection
Data Analysis
Oct - May

→

3
Results
Dissemination
AGU+9th Graders
May + Dec

↑

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Project Watershed

2 Results Dissemination

To the 9th Grade Classroom:

Project Watershed students lead outdoor workshops for 9th Grade Integrated Science and Earth Science students from Burton, O'Connell and Mission high schools in Glen Canyon Park.

Topics Covered: Watersheds, Nonpoint Source Pollution and taught students to test for nitrates in Islais Creek.

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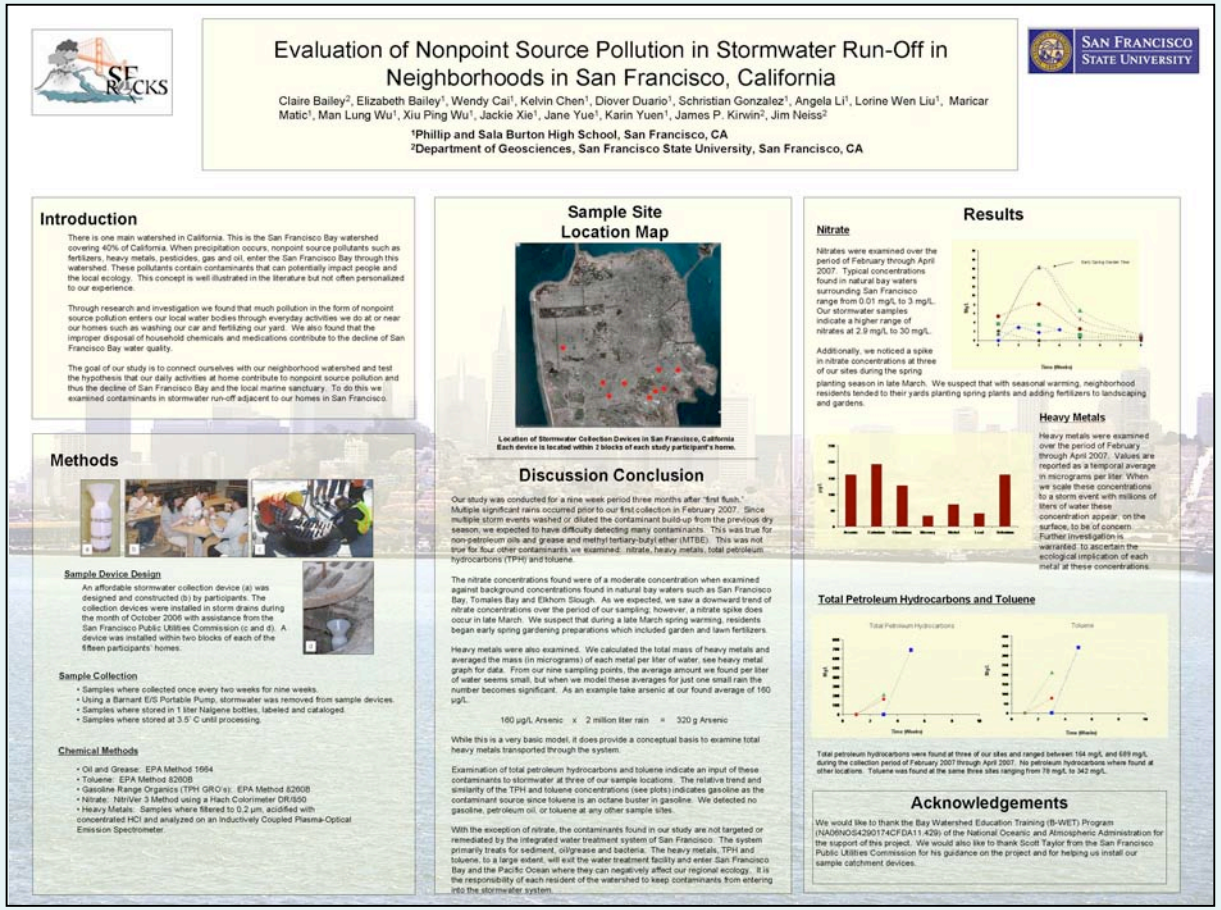
Reaching Out to Communities and Kids with Science in San Francisco

Project Watershed

② Results Dissemination

Presented by students at American Geophysical Union Fall Meeting, San Francisco, CA



Evaluation of Nonpoint Source Pollution in Stormwater Run-Off in Neighborhoods in San Francisco, California

Claire Bailey[2], Elizabeth Bailey[1], Wendy Cai[1], Kelvin Chen[1], Diover Duario[1], Schristian Gonzalez[1], Angela Li[1], Lorine Wen Liu[1], Maricar Matic[1], Man Lung Wu[1], Xiu Ping Wu[1], Jackie Xie[1], Jane Yue[1], Karin Yuen[1], James P. Kirwin[2], Jim Neiss[2]

[1]Phillip and Sala Burton High School, San Francisco, CA
[2]Department of Geosciences, San Francisco State University, San Francisco, CA

Introduction

There is one main watershed in California. This is the San Francisco Bay watershed covering 40% of California. When precipitation occurs, nonpoint source pollutants such as fertilizers, heavy metals, pesticides, gas and oil, enter the San Francisco Bay through this watershed. These pollutants contain contaminants that can potentially impact people and the local ecology. This concept is well illustrated in the literature but not often personalized to our experience.

Through research and investigation we found that much pollution in the form of nonpoint source pollution enters our local water bodies through everyday activities we do at or near our homes such as washing our car and fertilizing our yard. We also found that the improper disposal of household chemicals and medications contribute to the decline of San Francisco Bay water quality.

The goal of our study is to connect ourselves with our neighborhood watershed and test the hypothesis that our daily activities at home contribute to nonpoint source pollution and thus the decline of San Francisco Bay and the local marine sanctuary. To do this we examined contaminants in stormwater run-off adjacent to our homes in San Francisco.

Methods

Sample Device Design

An affordable stormwater collection device (a) was designed and constructed (b) by participants. The collection devices were installed in storm drains during the month of October 2006 with assistance from the San Francisco Public Utilities Commission (c and d). A device was installed within two blocks of each of the fifteen participants' homes.

Sample Collection

- Samples where collected once every two weeks for nine weeks.
- Using a Barnant E/S Portable Pump, stormwater was removed from sample devices.
- Samples where stored in 1 liter Nalgene bottles, labeled and cataloged.
- Samples where stored at 3.5° C until processing.

Chemical Methods

- Oil and Grease: EPA Method 1664
- Toluene: EPA Method 8260B
- Gasoline Range Organics (TPH GRO's): EPA Method 8260B
- Nitrate: NitriVer 3 Method using a Hach Colorimeter DR/850
- Heavy Metals: Samples where filtered to 0.2 µm, acidified with concentrated HCl and analyzed on an Inductively Coupled Plasma-Optical Emission Spectrometer.

Sample Site Location Map

Location of Stormwater Collection Devices in San Francisco, California
Each device is located within 2 blocks of each study participant's home.

Discussion Conclusion

Our study was conducted for a nine week period three months after "first flush." Multiple significant rains occurred prior to our first collection in February 2007. Since multiple storm events washed or diluted the contaminant build-up from the previous dry season, we expected to have difficulty detecting many contaminants. This was true for non-petroleum oils and grease and methyl tertiary-butyl ether (MTBE). This was not true for four other contaminants we examined: nitrate, heavy metals, total petroleum hydrocarbons (TPH) and toluene.

The nitrate concentrations found were of a moderate concentration when examined against background concentrations found in natural bay waters such as San Francisco Bay, Tomales Bay and Elkhorn Slough. As we expected, we saw a downward trend of nitrate concentrations over the period of our sampling; however, a nitrate spike does occur in late March. We suspect that during a late March spring warming, residents began early spring gardening preparations which included garden and lawn fertilizers.

Heavy metals were also examined. We calculated the total mass of heavy metals and averaged the mass (in micrograms) of each metal per liter of water, see heavy metal graph for data. From our nine sampling points, the average amount we found per liter of water seems small, but when we model these averages for just one small rain the number becomes significant. As an example take arsenic at our found average of 160 µg/L.

160 µg/L Arsenic x 2 million liter rain = 320 g Arsenic

While this is a very basic model, it does provide a conceptual basis to examine total heavy metals transported through the system.

Examination of total petroleum hydrocarbons and toluene indicate an input of these contaminants to stormwater at three of our sample locations. The relative trend and similarity of the TPH and toluene concentrations (see plots) indicates gasoline as the contaminant source since toluene is an octane buster in gasoline. We detected no gasoline, petroleum oil, or toluene at any other sample sites.

With the exception of nitrate, the contaminants found in our study are not targeted or remediated by the integrated water treatment system of San Francisco. The system primarily treats for sediment, oil/grease and bacteria. The heavy metals, TPH and toluene, to a large extent, will exit the water treatment facility and enter San Francisco Bay and the Pacific Ocean where they can negatively affect our regional ecology. It is the responsibility of each resident of the watershed to keep contaminants from entering into the stormwater system.

Results

Nitrate

Nitrates were examined over the period of February through April 2007. Typical concentrations found in natural bay waters surrounding San Francisco range from 0.01 mg/L to 3 mg/L. Our stormwater samples indicate a higher range of nitrates at 2.9 mg/L to 30 mg/L.

Additionally, we noticed a spike in nitrate concentrations at three of our sites during the spring planting season in late March. We suspect that with seasonal warming, neighborhood residents tended to their yards planting spring plants and adding fertilizers to landscaping and gardens.

Heavy Metals

Heavy metals were examined over the period of February through April 2007. Values are reported as a temporal average in micrograms per liter. When we scale these concentrations to a storm event with millions of liters of water these concentration appear, on the surface, to be of concern. Further investigation is warranted to ascertain the ecological implication of each metal at these concentrations.

Total Petroleum Hydrocarbons and Toluene

Total petroleum hydrocarbons were found at three of our sites and ranged between 164 mg/L and 689 mg/L during the collection period of February 2007 through April 2007. No petroleum hydrocarbons where found at other locations. Toluene was found at the same three sites ranging from 78 mg/L to 342 mg/L.

Acknowledgements

We would like to thank the Bay Watershed Education Training (B-WET) Program (NA06NOS4290174CFDA11.429) of the National Oceanic and Atmospheric Administration for the support of this project. We would also like to thank Scott Taylor from the San Francisco Public Utilities Commission for his guidance on the project and for helping us install our sample catchment devices.

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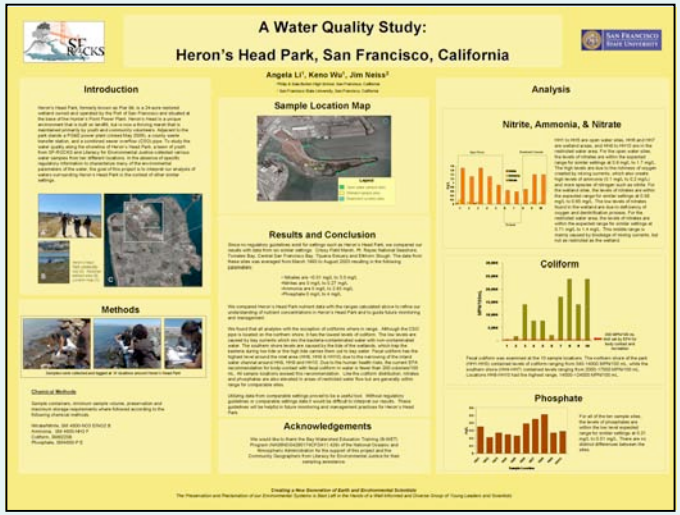
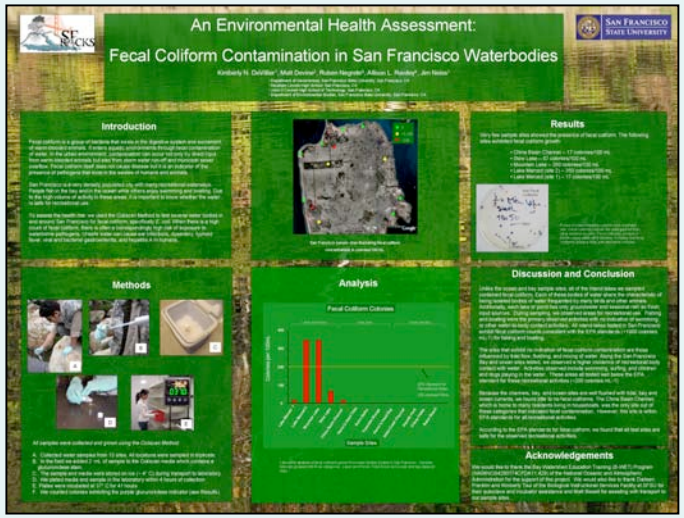
Project Watershed

"Can I Do More?"





A Few Students Requested to Do More:

- *A Water Quality Study: Heron's Head Park, San Francisco, California*
- *An Environmental Health Assessment: Fecal Coliform Contamination in San Francisco Waterbodies*

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Reaching Out to Communities and Kids with Science in San Francisco

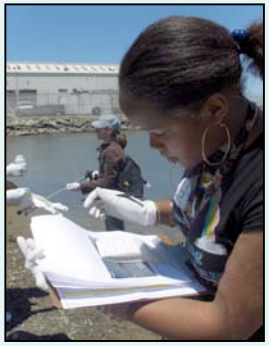
Project Watershed

A Water Quality Study: Heron's Head Park, San Francisco, California

- Five students from Literacy for Environmental Justice
- Two Project Watershed Students
- Sampled 10 sites in park.
- Examined:

  Nitrate/Nitrite, SM 4500-NO3 E/NO2 B
  Ammonia, SM 4500-NH3
  Coliform, SM9223B
  Phosphate, SM4500-P E

Site Location Map



A Water Quality Study:

Heron's Head Park, San Francisco, California

Angela Li[1], Keno Wu[1], Jim Neiss[2]

[1] Philip & Sala Burton High School, San Francisco, California

[2] San Francisco State University, San Francisco, California

Introduction

Heron's Head Park, formerly known as Pier 98, is a 24-acre restored wetland owned and operated by the Port of San Francisco and situated at the base of the Hunter's Point Power Plant. Heron's Head is a unique environment that is built on landfill, but is now a thriving marsh that is maintained primarily by youth and community volunteers. Adjacent to the park stands a PG&E power plant (closed May 2006), a county waste transfer station, and a combined sewer overflow (CSO) pipe. To study the water quality along the shoreline of Heron's Head Park, a team of youth from SF-ROCKS and Literacy for Environmental Justice collected various water samples from ten different locations. In the absence of specific regulatory information to characterize many of the environmental parameters of the water, the goal of this project is to interpret our analysis of waters surrounding Heron's Head Park in the context of other similar settings.

Heron's Head Park community trail (A). Restored wetland area (B). Location map (C).

Methods

Samples were collected and logged at 10 locations around Heron's Head Park

Chemical Methods

Sample containers, minimum sample volume, preservation and maximum storage requirements where followed according to the following chemical methods.

Nitrate/Nitrite, SM 4500-NO3 E/NO2 B
Ammonia, SM 4500-NH3 F
Coliform, SM9223B
Phosphate, SM4500-P E

Sample Location Map

Results and Conclusion

Since no regulatory guidelines exist for settings such as Heron's Head Park, we compared our results with data from six similar settings: Crissy Field Marsh, Pt. Reyes National Seashore, Tomales Bay, Central San Francisco Bay, Tijuana Estuary and Elkhorn Slough. The data from these sites was averaged from March 1993 to August 2003 resulting in the following parameters:

- Nitrates are <0.01 mg/L to 3.0 mg/L
- Nitrites are 0 mg/L to 0.27 mg/L
- Ammonia are 0 mg/L to 2.83 mg/L
- Phosphate 0 mg/L to 4 mg/L

We compared Heron's Head Park nutrient data with the ranges calculated above to refine our understanding of nutrient concentrations in Heron's Head Park and to guide future monitoring and management.

We found that all analytes with the exception of coliforms where in range. Although the CSO pipe is located on the northern shore, it has the lowest levels of coliform. The low levels are caused by bay currents which mix the bacteria-contaminated water with non-contaminated water. The southern shore levels are caused by the tide of the wetlands, which trap the bacteria during low tide or the high tide carries them out to bay water. Fecal coliform has the highest level around the inlet area (HH8, HH9 & HH10) due to the narrowing of the inland water channel around HH8, HH9 and HH10. Due to the human health risks, the current EPA recommendation for body-contact with fecal coliform in water is fewer than 200 colonies/100 mL. All sample locations exceed this recommendation. Like the coliform distribution, nitrates and phosphates are also elevated in areas of restricted water flow but are generally within range for comparable sites.

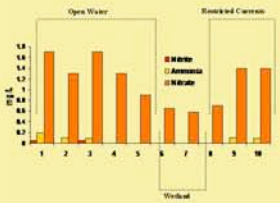
Utilizing data from comparable settings proved to be a useful tool. Without regulatory guidelines or comparable settings data it would be difficult to interpret our results. These guidelines will be helpful in future monitoring and management practices for Heron's Head Park.

Acknowledgements

We would like to thank the Bay Watershed Education Training (B-WET) Program (NA06NOS4290174CFDA11.429) of the National Oceanic and Atmospheric Administration for the support of this project and the Community Geographers from Literacy for Environmental Justice for their sampling assistance.

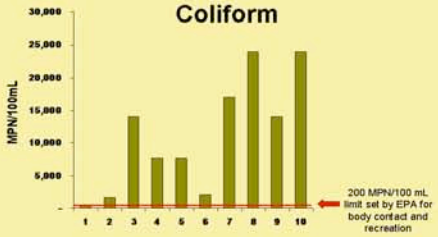
Analysis

Nitrite, Ammonia, & Nitrate



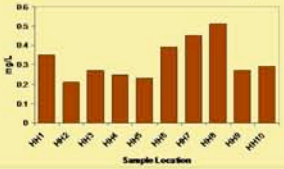
HH1 to HH5 are open water sites, HH6 and HH7 are wetland areas, and HH8 to HH10 are in the restricted water area. For the open water sites, the levels of nitrates are within the expected range for similar settings at 0.9 mg/L to 1.7 mg/L. The high levels are due to the richness of oxygen created by mixing currents, which also create high levels of ammonia (0.1 mg/L to 0.2 mg/L) and more species of nitrogen such as nitrite. For the wetland sites, the levels of nitrates are within the expected range for similar settings at 0.58 mg/L to 0.65 mg/L. The low levels of nitrates found in the wetland are due to deficiency of oxygen and denitrification process. For the restricted water area, the levels of nitrates are within the expected range for similar settings at 0.71 mg/L to 1.4 mg/L. This middle range is mainly caused by blockage of mixing currents, but not as restricted as the wetland.

Coliform



Fecal coliform was examined at the 10 sample locations. The northern shore of the park (HH1-HH3) contained levels of coliform ranging from 340-14000 MPN/100 mL, while the southern shore (HH4-HH7) contained levels ranging from 2000-17000 MPN/100 mL. Locations HH8-HH10 had the highest range, 14000->24000 MPN/100 mL.

Phosphate



For all of the ten sample sites, the levels of phosphates are within the low level expected range for similar settings at 0.21 mg/L to 0.51 mg/L. There are no distinct differences between the sites.

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** See the students' poster during the B-WET poster session.*

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Reaching Out to Communities and Kids with Science in San Francisco

Project Watershed

An Environmental Health Assessment:
Fecal Coliform Contamination in San Francisco Waterbodies

- Four Students
- Sampled 12 water locations in/around SF.
- Method: Coliscan
- Rated sites based on EPA guidance and human activities observed:
  - Green = 0 Colonies/ 100 mL
  - Yellow = 0 – 200 Colonies/100 mL
  - Red = > 200 Colonies/100 mL

Map of Sample Sites

An Environmental Health Assessment:

Fecal Coliform Contamination in San Francisco Waterbodies

Kimberly N. DeVillier[1], Matt Devine[2], Ruben Negrete[3], Allison L. Rawley[4], Jim Neiss[1]

[1] Department of Geosciences, San Francisco State University, San Francisco, CA
[2] Abraham Lincoln High School, San Francisco, CA
[3] John O'Connell High School of Technology, San Francisco, CA
[4] Department of Environmental Studies, San Francisco State University, San Francisco, CA

Introduction

Fecal coliform is a group of bacteria that exists in the digestive system and excrement of warm-blooded animals. It enters aquatic environments through fecal contamination of water. In the urban environment, contamination can occur not only by direct input from warm-blooded animals but also from storm water run-off and municipal sewer overflow. Fecal coliform itself does not cause disease but it is an indicator of the presence of pathogens that exist in the wastes of humans and animals.

San Francisco is a very densely populated city with many recreational waterways. People fish in the bay and in the ocean while others enjoy swimming and boating. Due to the high volume of activity in these areas, it is important to know whether the water is safe for recreational use.

To assess the health risk, we used the Coliscan Method to test several water bodies in and around San Francisco for fecal coliform, specifically *E. coli*. When there is a high count of fecal coliform, there is often a correspondingly high risk of exposure to waterborne pathogens. Unsafe water can cause ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis, and hepatitis A in humans.

San Francisco sample sites illustrating fecal coliform concentrations in colonies/100 mL.

Results

Very few sample sites showed the presence of fecal coliform. The following sites exhibited fecal coliform growth:

- China Basin Channel – 17 colonies/100 mL
- Stow Lake – 67 colonies/100 mL
- Mountain Lake – 350 colonies/100 mL
- Lake Merced (site 2) – 350 colonies/100 mL
- Lake Merced (site 1) – 17 colonies/100 mL

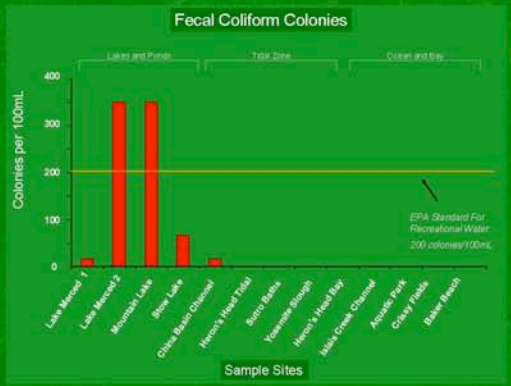
Picture of plated bacteria colonies from a sample site. Fecal coliform colonies are distinguished from other bacteria by color. Fecal coliforms produce a purple colony while other bacteria, including non-fecal coliforms, produce blue, pink and white colonies.

Methods

All samples were collected and grown using the Coliscan Method.

A. Collected water samples from 13 sites. All locations were sampled in triplicate.
B. In the field we added 2 mL of sample to the Coliscan media which contains a glucuronidase stain.
C. The sample and media were stored on ice (~ 4° C) during transport to laboratory.
D. We plated media and sample in the laboratory within 4 hours of collection
E. Plates were incubated at 37° C for 41 hours
F. We counted colonies exhibiting the purple glucuronidase indicator (see Results).

Analysis



Laboratory analysis of fecal coliforms grown from water bodies located in San Francisco. Samples sites are grouped into three categories: Lakes and Ponds, Tidal Zones and ocean and bay adjacent sites.

Discussion and Conclusion

Unlike the ocean and bay sample sites, all of the inland lakes we sampled contained fecal coliform. Each of these bodies of water share the characteristic of being isolated bodies of water frequented by many birds and other animals. Additionally, each lake or pond has only groundwater and seasonal rain as fresh input sources. During sampling, we observed areas for recreational use. Fishing and boating were the primary observed activities with no indication of swimming or other water-to-body contact activities. All inland lakes tested in San Francisco exhibit fecal coliform counts consistent with the EPA standards (<1000 colonies mL-1) for fishing and boating.

The sites that exhibit no indication of fecal coliform contamination are those influenced by tidal flow, flushing, and mixing of water. Along the San Francisco Bay and ocean sites tested, we observed a higher incidence of recreational body contact with water. Activities observed include swimming, surfing, and children and dogs playing in the water. These areas all tested well below the EPA standard for these recreational activities (<200 colonies mL-1)

Because the channels, bay, and ocean sites are well flushed with tidal, bay and ocean currents, we found little to no fecal coliforms. The China Basin Channel, which is home to many residents living in houseboats, was the only site out of these categories that indicated fecal contamination. However, this site is within EPA standards for all recreational activities.

According to the EPA standards for fecal coliform, we found that all test sites are safe for the observed recreational activities.

Acknowledgements

We would like to thank the Bay Watershed Education Training (B-WET) Program (NA06NOS4290174CFDA11.429) of the National Oceanic and Atmospheric Administration for the support of this project. We would also like to thank Darleen Franklin and Kimberly Tsui of the Biological Instructional Services Facility at SFSU for their autoclave and incubator assistance and Matt Bissell for assisting with transport to our sample sites.

** See the students' poster during the B-WET poster session.*

Project Watershed

Evaluation Plan (Year 1) – Pre/Post Test Questions

- What is a watershed?
- What is an estuary?
- What is the function of wetlands? How do they help the environment?
- Why are there few wetlands along San Francisco Bay?
- What is nonpoint source pollution? Where does most nonpoint source pollution come from?
- What is biomagnification? What contaminant is of particular concern here in the San Francisco area that biomagnifies? How was/is this contaminant introduced into the environment?

Project Watershed

Evaluation Plan (Year 1) – Pre/Post Test Questions **– Con't**

- Describe what happens to the water you wash down your kitchen sink or toilet. What is treated and what is not?

- What are some common contaminants locally (name at least five)? For two of these five, describe how they negatively effect the environment.

- What are three things you do in your house that negatively effect local water quality? What can you do to change these things?

Project Watershed

Responses Evaluated on Rubric Scale

0 Blank response or response contains no information related to question.	**1** Response demonstrates *limited* knowledge of facts, terms, concepts, and relationships	**2** Response demonstrates *some* knowledge of facts, terms, concepts, and relationships	**3** Response demonstrates *considerable* knowledge of facts, terms, concepts, and relationships	**4** Response demonstrates *thorough* knowledge of facts, terms, concepts, and relationships

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Reaching Out to Communities and Kids with Science in San Francisco

Project Watershed

Results

Question	Pre-Test Average	Post-Test Average	Percent Increase
What is a watershed?	0.1	3.6	88%
What is an estuary?	0.7	4	83%
What is the function of Wetlands? How do they help the environment?	0.7	3.8	93%
Why are there few wetlands in San Francisco Bay?	0.7	4	95%
What is non-point source pollution? Where does most non-point source pollution come from?	0.2	3.9	97%
What is biomagnification? What contaminant is of particular concern here in San Francisco area that biomagnifies? How was/is this contaminant introduced into the environment?	0	3.9	95%
Describe what happens to the water you wash down your kitchen sink or toilet? What is treated and what is not?	0.1	3.9	93%
What are some common contaminants locally (name at least five). For two of these five, describe how they negatively affect the environment.	0.1	4	98%
What are three things you do in your house that negatively effect local water quality? What can you do to change these things?	0.8	3.8	75%

Project Watershed

Lesson Learned/Upgrades Implemented

Evaluation Plan is deficient in scope as does not adequately capture the effort of program staff and participants.

New Evaluation Plan:

- Based on Demonstrative Learning Objectives of each lesson.
- Student demonstrate learning objectives after each lesson.
- Response rated on 4 pt. rubric scale.
- Unique Identifiers for each student
    - Track progress as group and for individuals
- Same pre/post test as year 1.
- Two SFSU faculty will rate poster (output) on same 4 pt. rubric scale.

Project Watershed

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