

Final Report

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

EPA Assistance No. NE-97586701-0

Barbara Keller, Ph.D., Lake Superior State University

Gene Wicks, Ph.D., Lake Superior State University

Michelle Ribant, EUP Intermediate School District Math/Science Center

Matthew Sinkovich, LSSU Senior in Environmental Health

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

Abstract:

The goals of this project were 1) to work with area high school students on a project that highlights the human-health risks associated with surface-water biological contamination in a popular, nearby recreation area and 2) to encourage environmental careers by involving students in field work to assess the issue. The project involved a total of 58 high school science students from five school districts: Les Cheneaux Community Schools, Sault Ste. Marie Area Schools, Rudyard Area Schools, Pickford Public Schools, and Brimley Area Schools. High school participants from the latter four school districts were enrolled in Lake Superior State University's (LSSU's) Upward Bound Program during the 2002 Summer Session. All participants were associated with the Eastern Upper Peninsula Intermediate School District's Math/Science Center. The participating high school students and teachers worked with LSSU Environmental Health students and faculty, the Math/Science Center Director, and Luce, Mackinac, Alger, and Schoolcraft (LMAS) District Health Department staff to test for biological contamination and make recommendations to regulators regarding how the findings impact human health. The project participants planned and carried out a series of sampling events to test for both *E. coli* and coliform at Les Cheneaux Islands Area beaches. Samples were also tested for pH, temperature, and dissolved oxygen (DO). Sampling events were conducted in July, October, and November of 2002 and in May of 2003. The Michigan Department of Environmental Quality (MDEQ) has established Total Coliform and *E. coli* limits for Michigan Beaches at 500 CFU per 100mL sample and 300 CFU per 100 mL sample, respectively. At two of the six sampling sites, this study found bacteriological results exceeding these limits one or more times during the year. The results of the study were shared with the LMAS District Health Department, the Michigan Department of Community Health, area residents via school mailings, and the local Les Cheneaux Watershed group. When the data indicated there was a problem with biological contamination, the authorities were notified so that they could issue a body contact warning and conduct further tests to determine the source of the contamination. Results of this study, along with land use information, recorded air temperature, wind velocity, and precipitation events, were used in an LSSU Environmental Health student's senior project to create an empirical model that may be used to predict bacteriological contamination levels. Potential sources of contamination include residential septic systems, runoff from area fields and forests, and dumping of wastes from ships in the general vicinity of the beach areas.

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

Introduction:

Project Goals:

This project involved high school and university science students, associated high school science teachers, Lake Superior State University (LSSU) faculty, Eastern Upper Peninsula (EUP) Math/Science Center staff, and local public health officials. The overall goal was to bring all of these people together in order to explore surface water quality with regard to bacteriological contamination and its potential impact on human health. Specifically, the goals and objectives were to:

- 1) Determine sampling sites and conduct three sampling events at five locations in the Les Cheneaux Islands area and one control site just outside the Les Cheneaux Islands.
- 2) Analyze the collected samples for Total Coliform, *E. coli*, dissolved oxygen, temperature, and pH.
- 3) Provide results of the study to area public health officials and local residents for use in future environmental policy-making decisions.
- 4) Encourage students to pursue environmental careers by involving high school and university students in the design, fieldwork, and laboratory analysis portions of the project. The students also interacted with LSSU Environmental Health faculty, EUP Math/Science Center staff, and local public health officials, who are all individuals with careers in science.
- 5) Provide a field-related working internship for an LSSU Environmental Health student.

Background Information:

The Les Cheneaux Islands area is located in Mackinac County in Michigan's Eastern Upper Peninsula (Figure 1). The area includes a 36-island archipelago in the northernmost part of Lake Huron, east of the Straits of Mackinac. In this region, residents depend on the surface water for their recreational and economic livelihood as well as, in some instances, to provide water for summer residential use. In addition to vast shoreline areas, the region has numerous creeks discharging into its surface waters. The watershed for this region covers 145 square miles consisting of approximately 74% forest, 15% wetlands, 5% urban (mostly strip commercial development), and 1% agricultural. The remainder is open and barren land.

The small communities of Cedarville and Hessel are located in the project area. The year round population is approximately 2000 people with a large increase in number of summer residents. This seasonal population increase combined with the intense recreational use of the area's surface waters has raised questions about the bacteriological quality of the water, particularly during the summer months. At present there is no ongoing bathing beach monitoring program so there is no way of knowing whether recommended bacteriological contamination levels are being exceeded. The lack of monitoring may put local residents and those that visit the area in the busy summer

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

season at risk of contact with a variety of biological pathogens. In addition to the surface water posing a body contact risk, past investigations by the local health department have uncovered numerous summer residences utilizing untreated surface water. These supplies may be used for both potable and non-potable purposes. Thus, there is a risk that some people may ingest bacteriological contaminants. There is also potential risk to area fish and plant life due to excessive nutrient loading from the same source as the potential bacteriological contamination.

Project Activities:

This project brought together participating partners from Lake Superior State University, Les Cheneaux High School, the EUP Math/Science Center, LSSU's Upward Bound Program, and the LMAS District Health Department to discuss the proposed work plan and determine sampling point locations. It is worth noting that the Upward Bound Program was composed of high school students from Sault Ste. Marie Area Schools, Rudyard Area Schools, Pickford Public Schools, and Brimley Area Schools for the duration of the project.

During the week of July 1, 2002, 42 Upward Bound students, who were enrolled in a six-week summer session at LSSU, met with the EUP Math/Science Center Director, LSSU project personnel, and an LSSU environmental health student to discuss the biological contamination project. An initial survey was given to assess the students' knowledge prior to carrying out the project. Then the students were trained to test water samples for pH, dissolved oxygen (DO) levels, and temperature as well as appropriate methods for collecting water samples for coliform and *E. coli* analysis.

The first sampling event took place on July 8, 2002, during and after a steady rain lasting for approximately 4 hours. Upward Bound students collected surface water samples from the six beach sites to test for coliform and *E. coli*, and they processed the samples, with the assistance of project staff, upon returning to LSSU. Because two sites showed unexpectedly high results, project staff members returned to the Islands on July 16 and re-sampled the six sites in dry weather for comparison purposes. The data collected from both sampling events were shared with the Upward Bound students. Dr. Wicks and Ms. Dommerman, the Upward Bound chemistry and biology teachers, respectively, led a discussion of the results to ensure that the students understood the data, understood the ramifications of the high results, and participated in the associated thought processes. The Upward Bound students completed the post-assessment on July 19. Results for the remainder of the project will be shared with them on June 23, 2003, which is the first day of this year's Upward Bound Summer Session.

On September 26, Dr. Wicks introduced the biological contamination project to Mr. St. Onge's Conservation Class at Les Cheneaux High School in Cedarville, Michigan. The pre-assessment and field work training for these 16 students were completed at that time.

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

The fall sampling event took place on October 8, 2002. The EUP Math/Science Center Director, LSSU project personnel, and LSSU environmental health student met early in the morning with the Les Cheneaux High School students for some hands-on training. Afterward, the students sampled the six study sites. The samples were returned to LSSU for processing. Data collected from this event were forwarded to Mr. St. Onge, the Les Cheneaux High School science teacher, for discussion with his students. These students also participated in a sampling event on May 14, 2003, and project data were again forwarded to Mr. St. Onge to share with his students. Students completed the post-assessment on May 14. Appendix A gives an example of the permission slips required to transport students in LSSU vans. Appendix B is a picture gallery showing the students collecting samples at various times throughout the project's duration.

A winter sampling event took place on November 19, 2002. This event involved Matt Sinkovich, a senior Environmental Health student at LSSU. This was an extra sampling event that we determined was needed to provide additional data for this project and for Matt's senior thesis project.

The Michigan Department of Community Health bathing beaches protocol, EPA Method 325.2102, was followed for the collection of all samples (1). The samples were collected one foot below the surface in water that was 3 feet deep. The pH, temperature and DO levels were obtained onsite. For each Total Coliform and *E. coli* sample, 100 mL of water was collected in a sterile, 100-mL polypropylene bottle. At each site, the samples were collected in triplicate using sterile technique and placed in coolers containing ice for transport back to the laboratory. The samples were analyzed in the laboratory using the Colisure Quantitray Method, an EPA approved procedure. All sample locations were positioned using a Garmin eTrex Legend, and a map of the region was created in LSSU's Geographic Information System (GIS) laboratory.

During each sampling event, the LSSU Environmental Health student collected information on meteorological parameters from the National Climatic Data Center (2) that included average air temperature, two-day mean precipitation, four-day mean precipitation, two-day average wind velocity, and four-day average wind velocity. Information on land usages was also determined from the geospatial data downloaded from the Michigan Center for Geographic Information (CGI) website (3). The meteorological data and land-use information, along with the bacteriological data that was collected during this project, was used to prepare a mathematical model that perhaps can be used to predict bacteriological levels along the beaches in this area. This part of the study went beyond the original scope of the project, but was added to enhance the student educational component of this project. The resulting model was used by the LSSU Environmental Health student as his senior thesis project. A copy of the final report submitted by this student is included with the packet of materials submitted with this final project report.

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

Project Results:

Sampling Locations:

Sampling locations were chosen on the basis of their access for public swimming, where bacteriological contamination poses the greatest risk to humans. Six sampling site locations were selected. The selected locations included beaches, boat launches, and campgrounds. Figure 2 is a map showing the locations of the sampling sites. The locations included:

- Location #1: Search Bay Campground
This small campground is located far from any manmade structures in the heavily wooded Hiawatha National Forest. It is approximately 1.5 miles from a state road.
- Location #2: Hessel Beach
This public bathing beach is located in the town of Hessel. There are many homes and businesses in the vicinity of this popular beach.
- Location #3: Cedarville Boat Launch
This site is located in the town of Cedarville. It is an area of major concern that has experienced a large increase in algal blooms caused by increased phosphate loading in the water. The river mouth for Pearson Creek is adjacent to the boat launch.
- Location #4: Hill Island Road
This site is located near the middle of a causeway leading to Hill Island.
- Location #5: McKay Bay Boat Launch
This site serves as a docking point for many larger vessels that commute between the different islands.
- Location #6: Picnic Area on M-134
This site is the control location. It is located approximately 10 miles outside the Les Cheneaux Islands area and is a site with limited public impact.

Analytical Results:

Water samples were collected in triplicate at each of the six locations. They were analyzed for Total Coliform, *E. coli*, DO, temperature, and pH using the methods previously described. Sampling was carried out throughout the entire year to see if seasonal variations were observed. Sampling events occurred on July 8, July 15, October 8, and November 19, 2002 and on May 14, 2003. Triplicate samples were collected

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

during each sampling event. Averaged results are shown in Tables 1 through 5 below. Figures 3 and 4 depict the Total Coliform and *E. coli* results graphically.

Table 1. Averaged Total Coliform results in colony forming units (CFU) per 100 mL of sample.

Location	7-8-02	7-15-02	10-8-02	11-19-02	5-14-03
Search Bay Campground	21	<1	33	< 1	<1
Hessel Beach	455	242	47	34	7
Cedarville Boat Launch	>2419	994	368	13	938
Hill Island Road	452	246	<1	112	79
McKay Bay Boat Launch	>2419	170	4	220	21
Picnic Area on M-134	155	39	< 1	<1	<1

Table 2. Averaged *E. coli* results in CFU per 100 mL of sample.

Location	7-8-02	7-15-02	10-8-02	11-19-02	5-14-03
Search Bay Campground	<1	<1	5	<1	<1
Hessel Beach	36	7	4	<1	1
Cedarville Boat Launch	222	93	78	3	8
Hill Island Road	3	20	<1	<1	5
McKay Bay Boat Launch	> 800	<1	1	13	<1
Picnic Area on M-134	28	12	<1	<1	<1

Table 3. Averaged pH values.

Location	7-8-02	7-15-02	10-8-02	11-19-02	5-14-03
Search Bay Campground	8.12	7.83	6.99	7.96	7.83
Hessel Beach	8.27	7.75	7.63	8.05	7.80
Cedarville Boat Launch	7.65	7.37	7.58	7.81	6.80
Hill Island Road	8.10	8.50	8.09	7.88	7.64
McKay Bay Boat Launch	8.21	8.38	8.10	7.91	7.51
Picnic Area on M-134	8.30	8.38	7.99	7.35	7.84

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Table 4. Averaged Dissolved Oxygen (DO) values in mg/L.

Location	7-8-02	7-15-02	10-8-02	11-19-02	5-14-03
Search Bay Campground	9.7	11.7	9.7	13.4	12.4
Hessel Beach	9.0	9.8	9.7	14.3	11.6
Cedarville Boat Launch	6.5	8.4	9.1	12.7	8.8
Hill Island Road	7.6	9.1	10.4	13.5	9.3
McKay Bay Boat Launch	10.2	12.6	9.9	14.2	11.6
Picnic Area on M-134	10.3	9.9	11.2	13.9	12.6

Table 5. Averaged water temperature values in °C.

Location	7-8-02	7-15-02	10-8-02	11-19-02	5-14-03
Search Bay Campground	18.4	16.3	10.0	4.4	8.9
Hessel Beach	21.3	25.0	10.3	3.1	10.9
Cedarville Boat Launch	22.6	23.7	8.4	0.5	12.3
Hill Island Road	24.3	27.0	8.5	3.1	14.3
McKay Bay Boat Launch	16.6	12.5	10.3	1.6	11.5
Picnic Area on M-134	17.2	18.3	7.8	3.8	10.5

Discussion of Results:

The Michigan Department of Environmental Quality (MDEQ) has set the State beach daily geometric mean at 500 colony forming units (CFU) per 100 mL of water for Total Coliform samples and at 300 CFU per 100 mL of water for *E. coli* samples. Analysis of samples that were collected on July 8 showed extremely high levels of Total Coliform and *E. coli* at the McKay Bay Boat Launch sampling site. The Total Coliform and *E. coli* levels during this sampling event were >2419 CFU/100 mL and > 800 CFU/100 mL, respectively. Additionally, the Cedarville Boat Launch sampling site also had high levels of Total Coliform, with values >2419 CFU/100 mL. While the *E. coli* results (222 CFU/100 mL sample) at the Cedarville Boat Launch did not exceed the MDEQ geometric mean of 300 CFU/100 mL sample, they were still quite high and therefore a concern.

Heavy rainfall had occurred on July 8, during the first sampling event, and it was not known whether the rainfall contributed to the high bacteriological levels. Therefore, a second sampling event was conducted on July 15 under sunny weather conditions, to verify the high bacteriological counts. The results from this July 15 sampling event showed high Total Coliform levels only for the Cedarville Boat Launch site, at 994 CFU/100 mL sample. These results suggest that the heavy rainfall may have influenced

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

the bacteriological levels at the beaches during the July 8 sampling event. However, it is also possible that bacteriological contamination from an unknown point source polluted the bathing beaches during the July 8 time period. A possible point source could be raw sewage dumped from a passing ship. Nevertheless, the LMAS District Health Department was notified of our findings.

The third and fourth sampling events (10-8-02 & 11-19-02) showed no results exceeding either of the MDEQ-approved Total Coliform or *E. coli* limits. The water temperatures during both of these sampling events had greatly decreased compared to the first two samplings. Since Total Coliform and *E. coli* are microorganisms that thrive at 37°C, it is possible that the cold water temperatures may have impacted these organisms. However, it is more probable that seasonal changes in human populations in the Les Cheneaux Islands area have contributed to these results. The summer months bring many tourists to the region, and the normal population of around 2,000 people increases significantly. The return of summer residents may be the reason for the increase in Total Coliform at the Cedarville Boat Launch observed during the May 14, 2003 sampling event.

A possible source of contamination for the Cedarville Boat Launch site is Pearson Creek, a small creek that empties into the Cedarville Bay next to the Boat Launch area. This creek runs past many possible contamination sources such as a local horse farm, rural homes that contain septic sewage systems, and the Cedarville sewage lagoons. It is possible that Pearson Creek may be carrying contamination into Cedarville Bay. Further investigation is required to verify whether this is happening. In separate work, Dr. David Szlag and one of his senior thesis students, both from LSSU, have taken an interest in this project and are beginning to investigate bacteriological and water quality parameters for Pearson Creek.

It is also worth noting that as a result of this study, the Chippewa County Health Department has applied for and obtained a grant to study surface water biological contamination along the Chippewa County shoreline this summer. Chippewa County is directly north of Mackinac County, the county in which our biological contamination study took place.

The pH, temperature, and dissolved oxygen levels measured during this study were consistent with our expectations. As expected, DO levels increased during the colder months. In addition, the pH levels decreased slightly during the winter months. It is worth noting that the DO level at the Cedarville Boat Launch was consistently lower than the DO levels at all other sites for every sampling event in the study. In contrast, the Total Coliform level was the highest at the Cedarville Boat Launch for all sampling events except the one on November 19, 2002. This suggests that the DO level may be lower at the Cedarville site due to a large amount of aerobic bacteria in the water.

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Evaluation Forms and Results:

A pre-assessment/post-assessment strategy was used to evaluate the amount of student learning that took place during the project. Table 6 shows that 58 students completed the pre-assessment and 43 students completed the post-assessment. Table 7 shows the questions asked, the percent of correct respondents, and the percent improvement. The students showed a measurable gain in knowledge for all questions.

The 58 participants were from two separate groups comprised of 42 high school students attending the Upward Bound Summer Session and 16 Conservation Class students attending Les Cheneaux High School. The Conservation Class participants were primarily juniors and seniors whereas the Upward Bound students were evenly distributed in grades 9 through 12. Most of the Conservation class participants had completed a biology course and some of them had completed a chemistry course, but only half of the Upward Bound students had completed a biology course and less than one quarter had completed a chemistry course.

The Upward Bound Program is a federally-funded program for disadvantaged high school students who want to attend college one day. At the Summer Session, Upward Bound students from four nearby high schools live on LSSU's campus and attend six-week courses during June and July. All of the Program's science students participated in this project. Unfortunately, many of the students already had some familiarity with this project on the day the pre-assessment was given. This is likely why the pre-assessment results seem high for some of the questions.

The students marked their responses to the pre-assessment and post-assessment on a Scantron survey form, and the forms were machine scored. The survey forms were inspected for stray pencil marks and incomplete erasures before being machine scored. The error in the survey results is less than 1 %.

Table 6: Number of Students Completing Evaluation Forms

Number of students who completed the pre-assessment:	58
Number of students who completed the post-assessment:	43

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Table 7: Student Evaluation Form Results

<i>Question (Answer in Bold Type)</i>	<i>Correct Respondents</i>
(1) In the Biological Contamination Investigation of Surface Waters Near the Les Cheneaux Islands Area, we are:	
(a) determining whether there is biological contamination of beaches in the study area.	Pre-Test: 43 % Post-Test: 51
(b) determining whether study area residents utilizing untreated surface water for drinking are at risk for exposure to pathogens. (Pathogens are disease-producing organisms.)	% Increase: 8
(c) testing for <i>E. coli</i> and fecal coliform, temperature, pH, and dissolved oxygen.	
(d) all of these.	
(e) I don't know.	
(2) After the project data is collected and analyzed, the results and conclusions will be shared with:	
(a) science teachers and environmental science students at Les Cheneaux High School.	Pre-test: 45 % Post-test: 79
(b) students in the Upward Bound Program at Lake Superior State University.	% Increase: 34
(c) the LMAS District Health Department, government officials, and local homeowners.	
(d) all of these.	
(e) I don't know.	
(3) In our Biological Contamination Investigation of surface waters, we are:	
(a) determining the amount of <i>E. coli</i> and fecal coliform present in a specific volume of water.	Pre-test: 51 % Post-test: 72
(b) testing for the presence or absence of <i>E. coli</i> and fecal coliform.	% Increase: 21
(c) both (a) and (b).	
(d) neither (a) nor (b).	
(e) I don't know.	
(4) Total coliform tests are usually performed on potable water (drinking water). Fecal coliform tests are usually performed on:	
(a) untreated (nonpotable) water.	Pre-test: 26 % Post-test: 51
(b) wastewater.	% Increase: 25
(c) bathing water and swimming water.	
(d) all of these.	
(e) I don't know.	

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Table 7 Continued: Student Evaluation Form Results

<i>Question (Answer in Bold Type)</i>	<i>Correct Respondents</i>
(5) Potential sources of biological contamination in the study area include:	
(a) residential septic systems.	Pre-test: 50 %
(b) runoff from fields and forests.	Post-test: 82
(c) intense recreational use of area surface waters during the warm summer months.	% Increase: 32
(d) all of these.	
(e) I don't know.	
(6) pH testing gives environmental scientists information about:	
(a) amount of dissolved "electrolytes" in the water.	Pre-test: 65 %
(b) acidity or basicity of the water and amount of material that will react with an acid or a base.	Post-test: 81
	% Increase: 16
(c) both (a) and (b).	
(d) neither (a) nor (b).	
(e) I don't know.	
(7) In order to obtain accurate information from a pH meter, calibration with known standards is	
(a) essential and must be performed before each field trip and checked periodically during the field trip.	Pre-Test: 46 %
	Post-Test: 72
(b) sometimes helpful, but only needs to be performed once a year.	% Increase: 26
(c) needs to be performed only once by the manufacturer when the meter is first assembled.	
(d) not necessary at all.	
(e) I don't know.	
(8) The amount of dissolved oxygen in wastewater containing a large quantity of aerobic bacteria is expected to be _____ the amount of dissolved oxygen in water containing no bacteria. (Assume all other factors are the same for both samples.)	
(a) greater than	Pre-test: 28 %
(b) less than	Post-test: 35
(c) about the same as	% Increase: 7
(d) our study group has no expectations.	
(e) I don't know.	

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Table 7 Continued: Student Evaluation Form Results

<i>Question (Answer in Bold Type)</i>	<i>Correct Respondents</i>
(9) In order for environmental scientists to accurately obtain water quality data from their samples, the samples are usually analyzed:	
(a) as soon as possible after obtaining them.	Pre-test: 47 %
(b) within 7 days, but it is not necessary to rush to analyze them.	Post-test: 91
	% Increase: 44
(c) within 30 days.	
(d) within 1 year.	
(e) I don't know	
(10) How much have you learned about environmental science careers from this project?	
(a) I have learned a lot about environmental science careers from this project, and I am considering a future environmental science career as a result.	12 %
(b) I have learned a lot about environmental science careers from this project.	72
(c) I have learned a little about environmental science careers from this project.	12
(d) I have not learned much about environmental science careers from this project.	4
(e) My classmates and I have just begun this project, and I am unable to evaluate how much I have learned about environmental science careers from it yet.	0
(11) What is your opinion of this project?	
(a) I have learned a lot about biological contamination of surface waters from participating in this project and I think it has been an excellent project for me to be involved in.	54 %
(b) I have learned a little about biological contamination of surface waters from this project and I think it has been a good project for me to be involved in.	34
(c) I did not learn much about biological contamination of surface waters from this project, but it was still a worthwhile project for me to be involved in.	10
(d) I have learned very little about biological contamination of surface waters from this project, and I think the whole project was a waste of time.	2
(e) My classmates and I have just begun this project, and I am unable to evaluate how much I have learned about biological contamination of surface waters from it yet.	0
(12) Do you have any other comments you would like to add about the project or your involvement in it?	
• It was a fun project and I enjoyed doing it. I learned a lot and now I am considering a future career in environmental science.	
• I thought this was a very interesting and fun thing to be a part of. I especially liked seeing our results!!	

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Table 7 Continued: Student Evaluation Form Results

Responses to Question (12) Continued:

- It was a good learning experience and I am glad I was able to participate.
- I enjoyed being a part of this study. It was a good experience for us all. And I personally think we should test our water supply to see what we can find.
- I thought it was interesting to learn about *E. coli* and coliform bacteria somewhere so close to us, especially because we're the ones in control and we're the ones who get to tell people if this water is contaminated. I'm not a "science person" usually, but this was actually interesting to me.
- I thought the field trip was pretty cool and I learned a lot even though I am not into science that much!
- I thought this project was great! I had a good time and enjoyed learning about the water and potential contamination.
- I really had fun doing this project and I liked it but it is one of the things I am not totally interested in as I get older.
- I liked being involved in this project because it showed me how much bacteria is in the water in lakes.
- I think we should have had more waders. But I thought it was very interesting. I think all kids should get the opportunity to do this.
- I thought this project was very cool and interesting. I liked the outside part a lot.
- I enjoyed being a part of it. It was interesting to learn about.
- This project was a lot of fun!
- I had fun doing it.
- It was fun.
- I liked it.
- The class is more fun than it is hard.
- Maybe do the tests at another site around this area.
- I thought it was a cool project. Even though it was cut short by rain and our van broke down I still liked performing the experiments and learning about this stuff.
- It is unfortunate that the project was conducted on a rainy day, and that most likely affected the results. Otherwise, it was an enjoyable experience, and I look forward to doing it again.
- This project was fun minus the rain. It helped me learn more about how important it is to keep the water clean. We should do this in the middle of the school year.
- The project was fun but would have been better if it hadn't rained. It was shocking how much bacteria we found in the water.
- Make sure it isn't going to rain next time. And more swimming.
- It was a good project but I'm still not a big science fan. I'm planning for a law degree so I'm thinking science is OK but law is better.
- I think it was a worthwhile experiment. I just wish we had better results. I still don't think I will get a job in biology or anything that has to do with science.

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

Although the overall goals of the project were mentioned several times, only half of the students responded correctly to question 1 at the end of the project. This is likely due to the wording of the question. Some of the younger Upward Bound students, who tend to be concrete operational thinkers, may not have made the connection that "biological contamination" in response (a) refers to coliform and *E. coli* bacteria. Similarly, since "pathogens" in response (b) was not discussed and reinforced after the initial training for the project, they may not have understood the significance of the response. The most common incorrect answer was response (c), which directly related to the field work the students performed.

Although question 4, which distinguished between total coliform tests and fecal coliform tests, was challenging for many students, there was a 25 % increase in correct respondents from the beginning to the end of the project. The most difficult question on the assessment seemed to be question 8. Its purpose was to assess analytical thinking and problem solving using the concepts involved in the field work. A similar question was briefly discussed during the initial training. Project staff hoped that students would make the connection that aerobic bacteria use oxygen so DO levels would decrease as the amount of aerobic bacteria in surface water increased. The percentage of correct respondents increased 7% over the course of the project, but only a third of the students mastered the concept.

As one can see from the responses to questions 10-12, student opinions about the project were quite favorable. In question 10, nearly 84 % of the students indicated that they had "learned a lot about environmental science careers" as a result of the project. (While the field trips were in progress, several project staff members shared information about environmental science careers and stories about environmental projects in the area). In question 11, 88 % of the students indicated that the project had been a "good" or "excellent" project for them to be involved in. Verbal comments from the students were similarly positive as shown in the responses to question 12. The few negative comments centered mostly around the rain the Upward Bound students experienced during the first sampling event.

Project feedback from the teachers involved in the project was quite positive. All of them were interested in partnering with LSSU science faculty on future grant projects involving their students. If one considers the 58 high school students and the LSSU senior thesis student involved in the project, there were at least 59 people directly educated about water quality through this project.

Problems and Challenges:

Very few problems occurred during the execution of this project. The high levels of Total Coliform and *E. coli* discovered during the first sampling event led to a another July sampling event that was not part of the project's original design. (In addition, Matt

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

Sinkovich, an LSSU environmental health student, completed a winter sampling event in late November that was not in the project's original design.) Although the rain posed a potential problem during our first sampling event, the Upward Bound students seemed to take this in stride, and they were quite interested in the subsequent results showing high bacteriological levels at some of our study sites.

Dissemination of the Project Results:

Project results have been and are being disseminated in the following ways:

- Mr. Matt Sinkovich, a senior LSSU Environmental Health student, presented the results of this project along with additional data as a formal poster presentation at the Upper Peninsula ACS Chemistry Symposium for Undergraduates at Michigan Tech University in Houghton, MI. Matt also presented this work as a formal PowerPoint presentation to the LSSU chemistry faculty and other interested university personnel. The senior thesis presentations at LSSU are locally advertised and open to the general community.
- Les Cheneaux High School students are incorporating the results of this study into their 10-year ongoing watershed study in the Les Cheneaux Islands area. In addition, the project results were discussed with the Les Cheneaux High School Principal, who accompanied us on our May 14 field work.
- A copy of the final report will be presented to the LMAS District Health Department, the Chippewa County Health Department, Mr. Bob Smith of the Les Cheneaux Watershed Association, Mr. Pat Carr of the USDA Les Cheneaux Conservation District, and the science teachers involved in the project.
- Project results were shared with area homeowners via school mailings.
- If accepted, Dr. Wicks will share the results of this study at an upcoming Michigan Science Teachers Association Conference.
- A manuscript of this study's findings will be submitted for publication in either the *Journal of College Science Teaching* or *The Science Teacher*.

Description of Target Audience and Number of Participants:

The target audience for this project includes:

- Local community members
- LMAS District Public Health Department
- USDA Les Cheneaux Conservation District
- Les Cheneaux Watershed Association

The number of participants in this project:

- 16 high school Conservation students from Les Cheneaux High School

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

- 42 high school students participating in LSSU's Upward Bound Program. These students are from Sault Ste. Marie Area Schools, Rudyard Area Schools, Pickford Public Schools, and Brimley Area Schools
- 1 science teacher from Les Cheneaux High School
- 2 science teachers from the Upward Bound Program
- 1 LSSU environmental health student
- 2 LSSU environmental chemistry faculty/staff
- The director for the EUP Math/Science Center

Conclusion:

Overall, the results of this study have been very positive. The high school students demonstrated measurable gains in knowledge about water quality as a result of this project and the accompanying field work. In addition, there is evidence that the project generated increased interest in environmental science careers for some of them. The environmental health student from the university gained valuable experience assessing and evaluating an environmental health problem—skills which are necessary for him to make the transition from student to professional. The community, regional health departments, and local government agencies benefited from the information that was disseminated to them through presentations and final copies of this report.

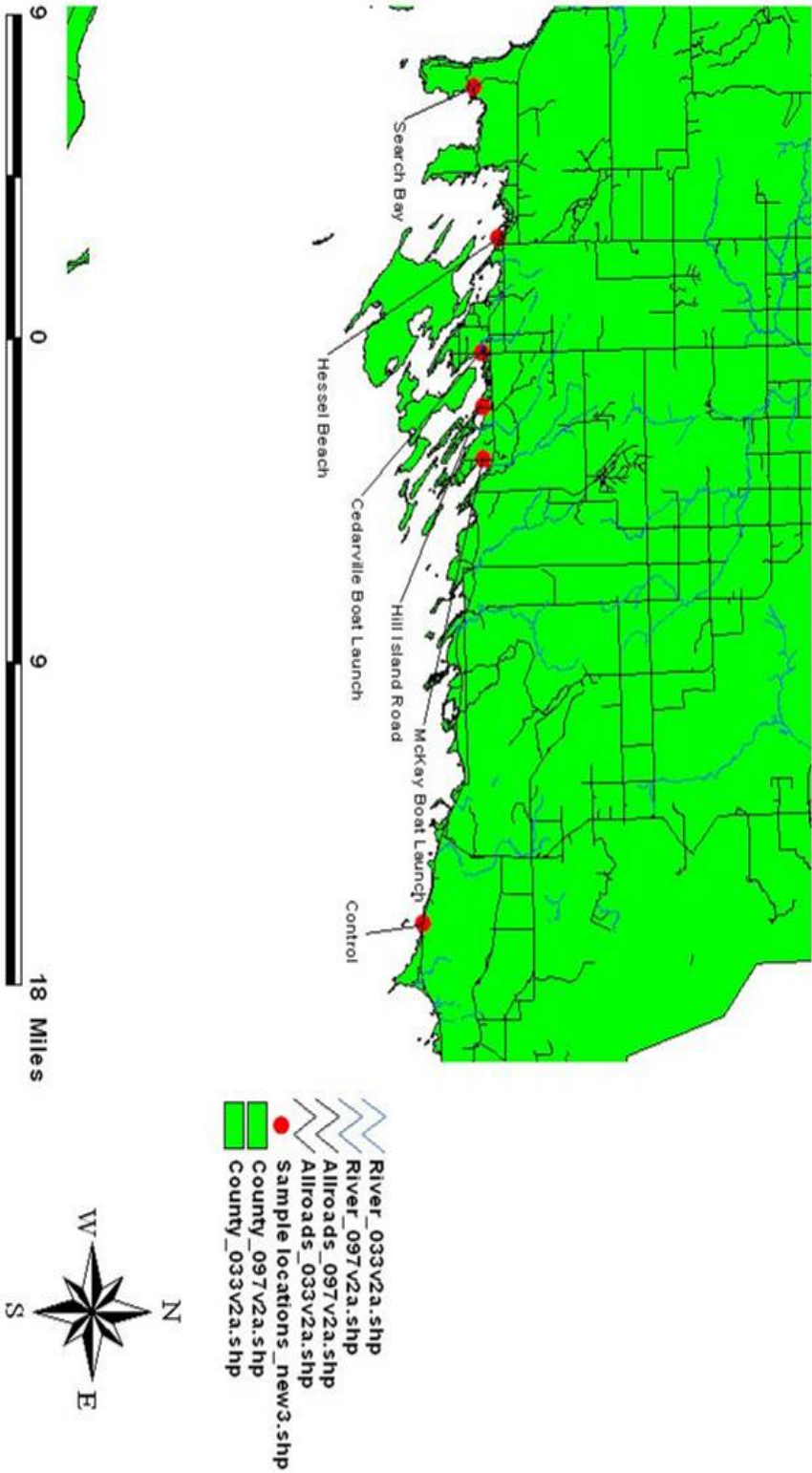
References:

1. United States Environmental Protection Agency, <http://www.epa.gov>, 2003.
2. National Climatic Data Center, <http://www.ncdc.noaa.gov>, 2003.
3. Michigan Geospatial Data Website, <http://www.michigan.gov/cgi>, 2003.

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area

Sample Locations



Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

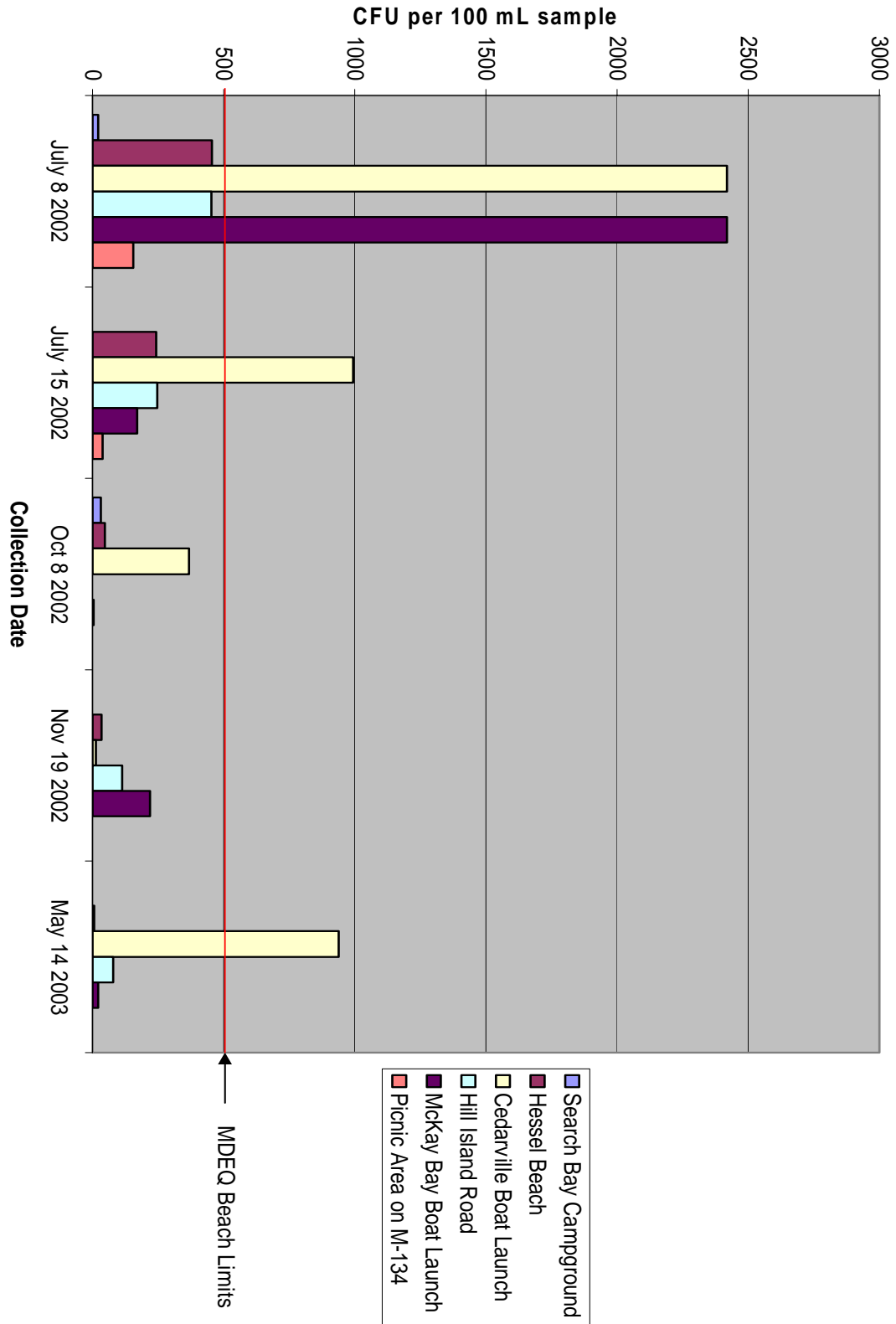


Figure 3
Averaged Total Coliform Count

Biological Contamination Investigation in Surface Waters Near the Les Cheneaux Islands Area

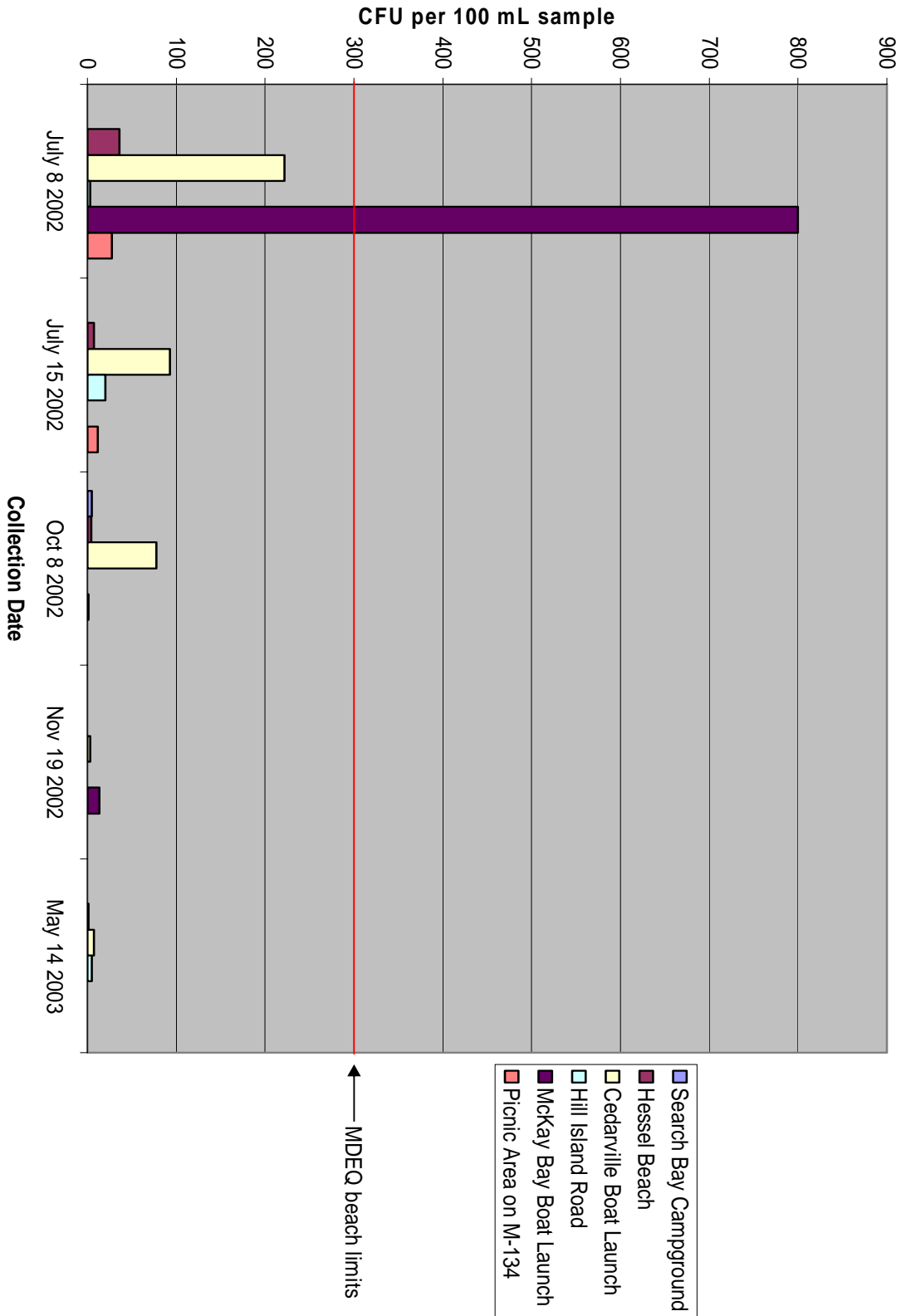


Figure 4
Averaged E. Coli Count

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Appendix A

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

**Travel Permission / Medical Release Form for a
Les Cheneaux Islands Area Water Quality Field Trip**

(Fall, 2002)

Environmental science students and staff from Lake Superior State University, high school students in LSSU's Upward Bound Program, and Conservation Class students from Les Cheneaux High School are collaborating on a joint project this school year to assess water quality in the Les Cheneaux Islands Area. We are particularly interested in assessing the amount of biological contamination in surface waters near area beaches. This joint project is supported by an environmental education grant from the U.S. Environmental Protection Agency. The Eastern Upper Peninsula Intermediate School District's Math / Science Center and the LMAS District Health Department are project partners.

As a part of this project, the Conservation Class students at Les Cheneaux High School will participate in two field trips during the school year. The students will be transported by project staff in vans owned by Lake Superior State University (LSSU). The first field trip will be:

8:20 – 11:50 AM, Tuesday, Oct. 8th

In order for LSSU staff to transport high school students, this travel permission / medical release form must be filled out and signed by a parent or guardian. This form is a student's "ticket" to ride in an LSSU van.

I GRANT PERMISSION FOR MY CHILD TO PARTICIPATE IN THE ABOVE FIELD TRIP WITH STAFF MEMBERS FROM LSSU, THE EASTERN UPPER PENINSULA INTERMEDIATE SCHOOL DISTRICT, AND LES CHENEAUX HIGH SCHOOL.

I GRANT PERMISSION FOR THE INFORMATION ON THIS FORM TO BE USED WHEN NECESSARY AS AN AID IN PROVIDING APPROPRIATE EMERGENCY HEALTH CARE WHILE MY CHILD IS WITH STAFF MEMBERS FROM LSSU, THE EASTERN UPPER PENINSULA INTERMEDIATE SCHOOL DISTRICT, AND LES CHENEAUX HIGH SCHOOL.

I UNDERSTAND THAT SHOULD A HEALTH EMERGENCY ARISE, EVERY ATTEMPT WILL BE MADE TO CONTACT ME THROUGH THE PHONE NUMBERS LISTED BELOW. IN THE EVENT THAT I CANNOT BE REACHED, I AUTHORIZE EMERGENCY MEDICAL TREATMENT AS DEEMED NECESSARY BY MEDICAL PERSONNEL.

Signature: _____ Relationship: _____

Date: _____ Home Phone: _____ Work Phone: _____

Alternate contacts if parent or guardian cannot be reached:

Name: _____ Relation: _____ Phone: _____

Name: _____ Relation: _____ Phone: _____

Name: _____ Relation: _____ Phone: _____

(Please turn over)

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Travel Permission / Medical Release Form, Page 2

Student's Medical History

General Health: _____ Date of last physical: _____

Any current health problems? Yes No

If Yes, please explain: _____

Any allergies? Yes No

If Yes, please explain: _____

Are you currently taking any medications? Yes No

If Yes, please explain: _____

Are there any activities the student should NOT take part in? Yes No

If Yes, please explain: _____

Medical Insurance Information

Medical Insurance Provider Name: _____

Policy Number: _____

Physician's Name: _____

Physician's Address: _____

Physician's Phone: _____

Thank you for providing this information for our records. The student's medical history and medical information will be kept on file for the duration of this project. When new travel permission / medical release slips are circulated for other project-related field trips, we will ask if there are any changes to a student's medical history and medical information.

**Biological Contamination Investigation in Surface Waters
Near the Les Cheneaux Islands Area**

Appendix B