NSF Highlights

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Including Non-Traditional Instrumentation in Undergraduate Environmental Chemistry Courses

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In 1998, with support from the National Science Foundation, Georgia Southern University's core curriculum began to require a course in environmental science, to be taken through the chemistry, geology, biology, or physics department. The primary goal was to enable all Georgia Southern undergraduates to achieve basic environmental literacy.

Chemistry 1040 was created as part of the core curriculum. Although the chemistry department already offered an advanced Environmental Chemistry course for majors (Chem 5243), the laboratory experiences were inappropriate for non-science majors; the instrument operation for non-majors needed to be simple enough to not impede the success of the experiment.

With further support from the National Science Foundation, we have acquired instrumentation that provides novel laboratory experiences in introductory and advanced courses. We report how we incorporated a direct mercury analyzer into both the non-major and advanced environmental laboratories.

Georgia Southern University is 1.5 hours from Brunswick, Glynn County, Georgia, an EPA Priority One Superfund Site for mercury contamination *(1)*. To capitalize on this unique situation, NSF funds were used, in part, to purchase a Milestone Direct Mercury Analyzer.[1] Mercury analysis is typically difficult, involving acid digestion and atomic absorption spectrophotometry with cold vapor deposition. The Milestone DMA-80 is the only commercially available direct mercury analyzer with autosampler that requires no acid pre-treatment. The instrument allows analysis down to 0.1 ppb and is safer than acid digestion methods, particularly for non-majors. The computer-controlled system has user friendly software, so there is a short learning curve for even novice users. A 40-boat autosampler is standard, and each analysis takes roughly 5 min with zero down time between runs. The local Superfund site and recent reports on mercury contaminated fish *(2)* bring home to students the relevance of mercury measurements. Since the system is a dedicated mercury graphite furnace that allows direct analysis, non-major students can bring a sample of canned, frozen, or fresh tuna, salmon, mackerel, and other fish tissue, cut off a piece, and load it into the sample tray. Total mercury is quantified based on a calibration curve that the students prepare using appropriate standards. (The standards are fish tissue powder purchased from the Canadian Research Council, and can be safely handled by students.) Typical results are shown in Table 1.

Table 1. Average Total Mercury Content in Commercially Available Seafood

Sample	Avg. [Hg] (ppb)	Standard Deviation
Salmon, canned	24.64	1.56
Lump crabmeat, canned	118.27	3.97
Sardines, canned	21.75	0.75
Baby shrimp, canned	46.86	3.30
Squid in ink sauce, canned	288.84	29.12
Herring, smoked	373.56	17.93
Mackerel filets, canned	243.53	23.27
Whiting filets, fresh	198.98	4.60

Note: All data represent 4 replicate measurements of each sample. The EPA limit for mercury in water is 0.30 ppm (U.S. EPA Fact Sheet "Mercury Update: Impact on Fish Advisories", EPA Pub. #823-F-01-011); the FDA action limit is 1.00 ppm (U.S. Food and Drug Administration FDA Consumer magazine September 1994 "Mercury in Fish: Cause For Concern?").

Majors and undergraduate research associates take field trips to Brunswick to acquire 1-meter sediment cores. Each core is divided into 10-cm segments and the mercury depth profile is determined. Results from two cores are shown in Table 2.

The Milestone DMA-80 has generated more student enthusiasm than we ever anticipated. We have had to deal with the unique situation of students wanting to be in the laboratory more hours than we can accommodate them. The thoughtfulness of the questions generated about effects of mercury in the body, food safety, and danger to aquatic organisms has been impressive.

Contamination by heavy metals, such as mercury, is a key topic in undergraduate environmental chemistry courses for both majors and non-major students. In creating new laboratory exercises, it is advantageous to make the work relevant *at a regional level.* Most of our students are from the surrounding areas, and when the work assigned has direct application to their lives, they are immediately at attention and receptive. When you have that, half the battle is won.

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Table 2. Mercury Depth Profile of Representative Core Samples

Depth (cm)	Core 1		Core 2	
	Avg. [Hg] (ppb)	Standard Deviation	Avg. [Hg] (ppb)	Standard Deviation
0–10	570.69	120.25	1266.11	122.45
10–20	770.15	356.04	1385.39	73.08
20–30	581.03	69.89	1474.1	217.88
30–40	887.09	116.15	1239.87	61.83
40–50	656.88	6.22	1715.32	153.72
50–60	1003.45	0.91	1670.38	186.52
60–70	232.33	20.59	2415.25	75.86
70–80	117.3	13.32	2519.18	421.24
80–90	102.69	19.51	20800.13	661.7
>90	79.64	13.02	11313.94	957.86

Note: Core 1 represents a sample upstream of the contamination site. Core 2 was taken approximately 100 yards from the site. All data are the average of 4 replicate measurements at each depth.

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Notes

1. The instrument purchased was a DMA-80 Direct Mercury Analyzer manufactured by Milestone Scientific Instruments (Monroe, CT) at an approximate price of $30,000.

Literature Cited

1. U.S. Environmental Protection Agency Web site at *http://www.epa.gov/region4/waste/npl/nplga/lcpincga.htm* (accessed Oct 2003).
2. Mendoza, M. Mercury Threat Lurks in Fish. *Atlanta Journal-Constitution,* October 13, 2002, A14.; Manning, A. If you eat a lot of fish, you may run health risk. *USA Today,* November 4, 2002, *http://www.usatoday.com/news/health/2002-11-04-fish-1acover_x.htm* (accessed Oct 2003)*;* Studies Conflict on Danger in Mercury-Laden Fish. *New York Times,* November 28, 2002, A30.

In the NSF Highlights column, recipients of NSF CCLI grants share their project plans and preliminary findings. J. David Jenkins, Jessica N. Orvis, C. Jimmy Smith, Citabria Manley, and Jeanette K. Rice are in the Department of Chemistry, Georgia Southern University, P. O. Box 8064, Statesboro, GA 30460; *jdjenkins@gasou.edu.