Mercury and Composting Fish Waste – A Pilot Project

by

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Project Report 08-01

April 2008

GREAT LAKES INDIAN FISH
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INTRODUCTION

In 2005, member tribes of the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) harvested around 60,000 walleye (*Sander vitreus*), along with smaller numbers of other fish species, from inland lakes in 1837 and 1842 treaty ceded waters of Wisconsin, Minnesota and Michigan (Milroy *et al.* 2007, Krueger 2006). Once the edible fillets have been removed, the resulting fish carcasses must be disposed of. One option is to use the carcasses as feedstock for creating fertilizer via composting. Composting provides a way of breaking down organic waste such as food scraps, yard waste and fish entrails and creating a natural fertilizer that is useful in gardening and farming. Composting reduces the amount of waste that is sent to landfills and the amount of chemical fertilizers that must be applied to the land to grow food.

GLIFWC collects and tests walleye and occasionally muskellunge fillets for total mercury concentration each year during spring harvest. The resulting mercury data are used to produce GIS-based, color-coded maps that are intended to help tribal members reduce their risk to mercury exposure by selecting lakes for harvest where walleye contain lower mercury concentrations. Because walleye and other fish contain mercury, concerns were raised about what happens to the mercury when fish are composted and whether there are any human health concerns from using fish-derived compost as a soil amendment to grow food in a garden.

Previous studies have looked into the feasibility of composting fish waste and testing for various organic and heavy metal contaminants in the initial or "bulking" materials used to make the compost pile and also in the finished compost. A study by Kinnunen *et al.* (2005) analyzed fish waste and the resulting compost and plant material grown from the compost for several organochlorine compounds (i.e. PCBs, DDT, etc.) and mercury. In general, the organochlorine compounds were not detected in the finished compost. Mercury was detected in the compost at similar levels to the original fish waste. The authors concluded that the organochlorine compounds were broken down during the composting process while mercury was not because of its properties as an element. Plants grown with the compost had no detections of organochlorine compounds and very low levels of mercury.

A project by Frederick *et al.* (1989) looked at concentrations of PCBs along with several heavy metals including: arsenic, cadmium, copper, and lead in compost derived from Great Lakes fish waste. The heavy metals were detected at levels significantly lower than in sewage sludge composts and fertilizers. They did not detect PCBs in the finished compost or in the plants grown from the finished compost.

In response to concerns about the potential presence of mercury in fish-derived compost and plants grown from soil amended with this compost, GLIFWC staff conducted a pilot project using fish waste from its annual spring mercury walleye collections. The primary purposes of this project were to demonstrate the process of composting fish waste and to follow the fate of mercury in the fish waste from the initial compost pile to the edible parts of plants grown in garden soil amended with the compost. The following report summarizes procedures used in making the compost pile, results from the garden plots and mercury concentrations in the compost, soil and corn from the garden plots.

METHODS

Collection and Processing of Fish

Walleye were collected from tribal spearers and netters and by GLIFWC fishery assessment crews during spring 2006. The fish were transported to GLIFWC where they were stored frozen prior to being processed. During processing, both fillets were removed from each fish, with one being sent to the Lake Superior Research Institute (LSRI) for mercury testing. The resulting fish carcasses were placed in black plastic trash bags and stored frozen until all fish were processed. Details of the collection and processing of fish for mercury analysis are described elsewhere (Hudson 2007).

Formation of the Compost Pile

Bulking Materials

Bulking materials are used in the composting process to allow air to enter the pile so bacteria and fungi do their work and to provide a proper carbon to nitrogen ratio (C:N ratio) so the material composts efficiently and without bad odors. Because fish waste contains a high amount of nitrogen, high-carbon bulking materials are desirable in order to provide the ideal C:N ratio of about 30 to 1 by weight (CWMI 1996). Other studies have used wood waste such as bark, wood chips and sawdust as bulking materials to effectively compost fish waste (Kinnunen *et al.* 2005, Frederick *et al.* 1989). These materials generally have a C:N ratio above 200:1, usually in the range of 400 to 500:1 (CWMI 1996). In addition, the micro-organisms that break down wood require excess amounts of nitrogen, which is readily available in the fish waste. Woody materials also are rigid enough to provide separation between materials in the compost pile and enhance airflow. Materials such as soil, wood chips, sawdust, leaves, grass clippings and straw can be used to cover the top of the compost pile to reduce odors.

Northern Wisconsin is a heavily forested region and therefore several sawmill and other forest products industries exist in the vicinity of the GLIFWC main office. By-products from the operations of many of these businesses include sawdust and wood chips, which make excellent bulking materials needed to compost fish waste. Bjork Wood Products (BWP) in Upson, WI was contacted and agreed to donate wood chips and sawdust for this project in 2006.

Creating the Pile

The goal in mixing together the pile was to have a C:N ratio between 30 and 40 to 1 by weight and a percent moisture between 40% and 60%. Moisture percentages below 40% tend to impede microbial degradation and percentages above 60% can lead to anaerobic degradation, which causes odor problems.

In order to increase chances for a successful compost pile, a compost "recipe" was calculated using available information on C:N ratios and percent moisture of various composting materials. Percent moisture for the fish waste was estimated using the mean value for walleye muscle tissue reported by LSRI for GLIFWC's walleye mercury testing program in 2005 (Markee *et al.* 2005). Percent moisture for the wood chips, sawdust and leaves was measured by taking a subsample of each material in triplicate and weighing it on a balance (OHAUS Analytical Plus) before and after drying it for two weeks in an oven at 120ºC. All other percent moisture values and the C:N ratios for each bulking material were estimated from Cornell University's "On-Farm Composting Handbook" (Rynk *et al*. 1992). In order to determine the mass of bulking material needed, the mass of fish waste to be composted was estimated. This was accomplished by calculating the mean round weight of the walleye collected for the mercury program in the previous two years (2004, 2005), subtracting the mean weight of the fillets removed for mercury testing and multiplying by the target number of walleye that were to be collected in 2006 (Table 1).

Table 1. Estimated weight (in lbs.) of walleye carcasses that were to be composted in the spring of 2006.

Mean Walleye Round Wt. 2004-05	Mean Wt. of Fillets Removed 2004-05	Mean Walleye Carcass Wt. 2004-05	Target Number of Walleye to Collect 2006	Estimated Wt. of Walleye Carcasses to be Composted
2.09	0.46	1.63	430	700

An equation was developed to estimate the amount of bulking materials needed to add to the pile after an estimate of the weight of fish waste was known (Equation 1). When entered into a Microsoft Excel spreadsheet, the equation allowed the user to change the weight and percent moisture of a bulking material needed in order to end up near the target C:N ratio and percent moisture for the pile. Ultimately, these estimates were only a starting point to figure out which bulking materials might work best based on their typical C:N ratios and percent moisture. The variability in both of these parameters is likely to be high depending on, for example, the species of trees used to make the wood chips or sawdust and how long those materials had been either dried out or moistened based on how they were stored.

Equation 1:

$$\frac{\%C_{material1}*(Mass_{material1}*[1-\%moisture_{material1}])+\%C_{material2}*(Mass_{material2}*[1-\%moisture_{material2}])+materials3,4,etc.}{\%N_{material1}*(Mass_{material1}*[1-\%moisture_{material1}])+\%N_{material2}*(Mass_{material2}*[1-\%moisture_{material2}])+materials3,4,etc.}$$

For the purposes of this pilot project, both the weight and the volume of bulking materials and fish waste were measured when the pile was created (Table 2). Weight (using a Pelouze Model 4010 scale) was the primary measurement used to create the pile because it was used to estimate the amounts of the various materials needed. Volume was measured using a polyethylene tote with an approximate volume of 0.092 yd^3.

Table 2. Approximate weight, volume, percent moisture and carbon to nitrogen ratio of materials added to the compost pile.

Bulking Material	Weight (lbs)	Volume (yd^3)	% Moisture	Estimated C:N Ratio*
Fish Waste	656	0.552	79.0**	5
Wood Chips	504	1.84	23.3	600
Sawdust	437	1.38	64.4	442
Leaves	25	0.276	22.7	54
Straw/Hay*	76	0.368	12.0*	80
Pile Totals	1698	4.42	54.7	40.4

* Estimates from Cornell University's "On-Farm Composting Handbook" (Rynk *et al*. 1992).
** Mean value for walleye muscle tissue reported by LSRI in 2005 (Markee *et al.* 2005).

The compost pile was created on 6/15/06. A layer of sawdust and wood chips was piled about four to six inches deep to form the base of the pile. A layer of fish waste about six inches deep was piled on top of the base layer, followed by alternating layers of sawdust/wood chips and fish waste until all the fish waste was incorporated into the pile. The resulting pile was about six feet wide and four feet high. The ratio of bulking materials to fish waste was approximately 1.4 to 1 by weight and 5.8 to 1 by volume. Following the layering process, the pile was mixed manually using a pitchfork. After mixing, a six-inch layer of leaves, straw/hay and a blue tarp were put on top of the pile to help retain moisture and keep down odors (Figure 1).

Figure 1. Fish compost pile, completed on 6/15/06 (photo by M. Hudson).

Three noteworthy points deserve mention for developing future compost piles. First, the pile should be created as quickly as possible in order to minimize odors and fly attraction. Second, at least a 12-inch cover layer of leaves, straw, grass clippings, other compost or soil is recommended for the top of the pile after the fish waste and sawdust/wood chips are mixed together to further keep down odors. Third, volume may be a more practical and consistent way to estimate the amount of materials needed for the compost pile for a "back-yard" compost operation as it is easier to estimate visually than weight, which can also be highly variable due to changes in percent moisture.

Maintaining the Pile

The compost pile was stirred manually using a pitchfork about every six weeks through the summer and fall of 2006. The pile was not disturbed between the end of November 2006 and April 2007. Although temperature of the pile was not regularly monitored, by winter 2006, the temperature in the center of the pile was not noticeably warmer than the outside, indicating the composting process had slowed significantly or was complete.

A grab sample of the compost was taken on 4/2/07 and sent to the University of Wisconsin-Madison Soil and Forage Analysis Lab in Marshfield, WI where it was analyzed for pH, phosphorus, potassium, organic matter and C:N ratio. Details on methods used by the Soil and Forage Analysis Lab for these analyses are available on their website: (http://uwlab.soils.wisc.edu/madison/index.htm?../procedures.htm&contents.asp?menu=2).

Test Garden Plots

Developing the Plots

AmeriCorps VISTA volunteers, who work with the Bad River Gitiganing community gardening project, were contacted and agreed to help develop a test plot in the Bad River Community Garden. The main goals of the plot were to: 1) determine whether fish compost additions to soil led to increased amounts of mercury in kernels of corn from plants grown in the soil 2) monitor the growth and compare the yields between plants grown with the different treatments.

The VISTA volunteers developed a random plot layout of nine three foot by three foot plots where three separate treatments used to grow Bear Island corn (a multicolored flint corn) were compared. The three treatments, each prepared in triplicate, were amended with: 1) fish compost, 2) Creekwood (a pelletized chicken manure fertilizer), and 3) no compost (Table 3).

Table 3. Randomly generated test plot layout at the Bad River Community Garden. Each plot was nine square feet in size.

No Compost	Creekwood	No Compost
Fish Compost	Creekwood	Fish Compost
Creekwood	Fish Compost	No Compost

Prior to preparing the test plots on 6/8/07, a grab sample of the fish compost, which had been allowed to mature for one year, and soil from the test plot were collected in ziplock plastic bags and stored in a freezer (at or below 10ºC) to be analyzed for total mercury content.

Approximately two small wheelbarrow loads (~90 lbs) of fish compost and about one pound of Creekwood was added to each of the appropriate plots outlined in Table 3. The fish compost, Creekwood and no compost plots were all mixed with a garden hoe to incorporate each soil amendment with the existing soil. Bear Island corn was planted in two rows, two feet apart, every four inches within each of the nine plots, for a total of ten plantings per plot.

Monitoring the Plots

A soil sample was taken from each plot on 7/13/07 to determine the amount of available nitrogen. The grab samples were placed into plastic ziplock bags and stored in a refrigerator until transport on ice to the Soil and Forage Analysis Lab in Madison, WI. Samples were analyzed for nitrate nitrogen (NO_3-N) according to the method outlined on their website: (http://uwlab.soils.wisc.edu/files/procedures/nitrate_N.pdf).

Growth of the plants was monitored on two occasions (7/13 and 8/3/07) by measuring the distance from the ground to the base of the top leaf on each corn plant. These measurements, along with a visual analysis of relative plant health gave a qualitative indication of how well the plants were growing within each of the test plots.

Yield of corn (in bushels per acre) was planned to be determined at harvest (~ mid-September). Unfortunately, raccoons got into the plots and ate some of the corn, making a determination of yield impossible. However, enough corn remained within each test plot that a composite sample of kernels from several cobs within each type of treatment (one composite sample for each of three plots within each treatment) was taken for total mercury analysis. Cobs were harvested on 9/14/07 and frozen until the kernels were removed with a stainless steel knife and the three composite samples were made at the GLIFWC laboratory in Odanah, WI. Composite samples were frozen and transported on ice to LSRI for mercury analysis.

Mercury Analysis

Sample preparation and analysis for mercury was performed by LSRI according to their laboratory standard operating procedures, which are outlined elsewhere (Markee *et al.* 2005). Briefly, all samples (except soil) were prepared for digestion by freezing the samples in liquid nitrogen and then processing to a fine powder in a stainless steel commercial blender. The garden plot soil sample was mixed thoroughly in the ziplock bag before aliquots of the sample were removed for digestion. Each sample was analyzed for mercury and moisture content in triplicate.

RESULTS

Fish Compost Characteristics

Soil Analysis

The University of Wisconsin-Madison Soil and Forage Analysis Lab tested the fish compost for basic soil properties (Table 4). The test is frequently used by homeowners to determine nutrient needs for a lawn or garden soil.

Table 4. Fish compost nutrient characteristics from analysis at University of Wisconsin-Madison Soil and Forage Analysis Lab, Marshfield, WI.

Nutrient Parameter	Result
Carbon:Nitrogen Ratio	10.8:1
% Organic Matter	44.2
pH	5.9
Phosphorus (ppm)	175
Potassium (ppm)	1085
Nitrogen	0.15 lbs./acre*

*The lab recommends if this fish compost were a garden soil, 0.15 lbs. of nitrogen would need to be added per acre to provide adequate needs for plant growth.

Total Mercury

Analysis of the bulking materials for total mercury revealed a mean concentration of 0.214 (± 0.015) µg Hg/g for the fish waste, 0.025 (± 0.002) µg Hg/g in the leaves, while mercury was not detected in the sawdust or wood chips (Table 5). The straw/hay mixture was not tested for mercury, but concentrations were likely very low given the concentrations in the other plant-based components. The total mass of mercury in the initial compost pile was estimated by multiplying the mercury concentration in each bulking material by the mass of the bulking material added to the pile. The fish waste accounted for greater than 99% of the total mercury estimated to be in the compost pile initially (Table 5). It was assumed that the straw/hay did not contribute a significant amount of mercury to the pile.

Table 5. Total mercury concentrations (Hg Conc. = µg Hg/g), mass of mercury (µg) and percent moisture in bulking materials used to create the initial compost pile.

Sample ID	Hg Conc. (ww*)	Mean Hg Conc.	St. Dev. Hg Conc.	% Moisture	Mass of bulking material (kg ww)	Mass of bulking material (kg dw*)	Mass Hg	Mean Mass Hg	% of Hg in Pile
Fish Waste-1	0.203	0.214	0.015	0.79	298	63	60,494	63673	99.6
Fish Waste-2	0.231						68,838		
Fish Waste-3	0.207						61,686		
Sawdust-1	<0.0042	-	-	0.64	199	72	-	-	-
Sawdust-2	<0.0042								
Sawdust-3	<0.0042								
Wood Chips-1	<0.0042			0.23	229	176	-	-	-
Wood Chips-2	<0.0042	-	-						
Wood Chips-3	<0.0042								
Wood Chips-3 dup	<0.0042								
Leaves-1	0.026	0.025	0.002	0.23	11	8.5	286	275	0.4
Leaves-2	0.027						297		
Leaves-3	0.023						253		
Straw/Hay	NA			0.12	35	31	NA		
Totals					772	350		63,948	100

* "ww" = wet weight, "dw" = dry weight

After maturing for approximately 10 months, a composite grab sample of the fish compost was analyzed for total mercury by LSRI. A composite grab sample of the soil in the garden test plots prior to any compost addition was also analyzed for total mercury. The resulting mercury concentrations were converted to dry weight values by dividing the wet weight concentrations by one minus the percent moisture in each material. The mean dry weight mercury concentration in the initial fish waste was 0.182 (± 0.013) µg Hg/g, 0.392 (± 0.104) µg Hg/g in the final fish compost and 0.020 (± 0.002) µg Hg/g in the garden test plot soil prior to compost addition (Table 6).

Total mercury was not detected in any composite corn kernel samples collected from corn plants grown in each of the three garden test plots (Table 7).

Table 6. Wet weight (ww) and calculated dry weight (dw) total mercury concentration (Hg Conc. = µg Hg/g) estimates for the initial compost pile, final compost pile and garden soil prior to adding Creekwood or compost.

Sample ID	Hg Conc. (ww)	% Moisture	Hg Conc. (dw)
Fish Waste-1	0.203	79.0	0.173*
Fish Waste-2	0.231	79.0	0.197*
Fish Waste-3	0.207	79.0	0.176*
Fish Compost Pile-1	0.139	56.4	0.319
Fish Compost Pile-2	0.229	55.2	0.511
Fish Compost Pile-3	0.153	55.8	0.346
Garden Plot Soil-1	0.018	15.3	0.021
Garden Plot Soil-2	0.022	15.2	0.026
Garden Plot Soil-3	0.019	15.2	0.022

*It was assumed that all of the mercury in the initial compost pile came from the fish waste. The dry weight concentrations were calculated by dividing the total estimated mass of mercury in the fish waste by the total estimated dry mass of materials in the initial compost pile.

Table 7. Wet weight total mercury concentrations (Hg Conc. = µg Hg/g) and percent moisture measured in composite corn kernel samples from each test plot.

Sample	Hg Conc. (ww)	% Moisture
Creekwood-1 Corn	<0.0047	43.1
Creekwood-2 Corn	<0.0047	42.8
Creekwood-3 Corn	<0.0047	42.4
No Compost-1 Corn	<0.0047	47.0
No Compost-2 Corn	<0.0047	47.7
No Compost-3 Corn	<0.0047	47.5
Fish Compost-1 Corn	<0.0047	37.1
Fish Compost-2 Corn	<0.0047	38.5
Fish Compost-3 Corn	<0.0047	38.6

Test Plot Results

Growth

Corn plants grown in the soil amended with fish compost germinated first, grew fastest and looked healthier than plants in the Creekwood or no compost treatments (Figure 2, Table 8).

Figure 2. Photograph of corn test plot on 7/15/07. Corn plants grown in soil amended with fish compost are shown.

Table 8. Mean and standard deviation of corn plant height to the last full leaf on each plant in each treatment (leaf collar method). Measurements occurred on 8/3/2007.

Treatment	Mean Ht. (in)	St. Dev.
Fish Compost	49	6
Creekwood	43	7
No Compost	33	8

A grab sample was taken from each of the test plots on 7/13/07 to test for available or "pre-sidedress" nitrogen (NO_3-N). Results are displayed in Table 9.

Table 9. Results of available nitrogen analysis (NO_3-N in parts per million) of soil samples from each test plot on 7/13/2007.

Sample ID	NO_3-N	Mean NO_3-N	St. Dev.
Fish Compost 1	55.54	162.99	120.61
Fish Compost 2	293.45		
Fish Compost 3	139.98		
Creekwood 1	7.70	15.11	7.39
Creekwood 2	22.48		
Creekwood 3	15.16		
No Compost 1	7.95	6.07	3.62
No Compost 2	1.89		
No Compost 3	8.35		

DISCUSSION

The primary purposes of this project were to provide a demonstration of composting fish waste and to follow the fate of mercury in the fish waste from the initial compost pile to the edible parts of plants grown in garden soil amended with the compost.

In addition, the chemical characteristics of the fish compost from this study make it favorable for use as a garden fertilizer. Qualitatively, corn plants grown in soil amended with the fish compost responded significantly better than soil amended with Creekwood or that did not contain any compost. A likely reason was the amount of available nitrogen in the fish compost plots was significantly greater than the other test plots. In order to optimize plant growth and minimize potential leaching of excess nitrogen, users of this information will want to have a soil test done in their garden to determine what the nutrient needs are and what an appropriate amount of fish compost to add to their garden would be.

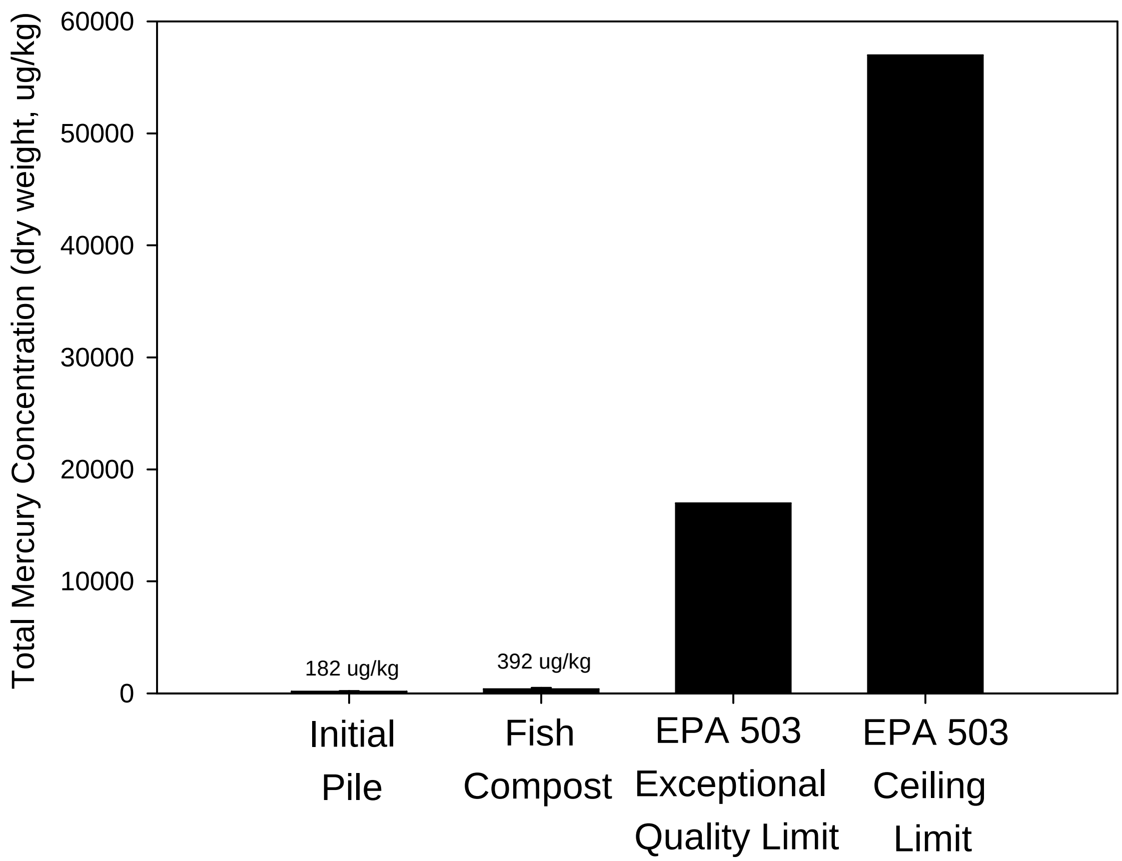
Greater than 99% of the mercury in the initial compost pile came from the fish waste. The leaves used to cover the pile contributed the remainder. The straw/hay was not analyzed for mercury but its contribution to total mercury in the pile was likely very low because there was a small mass of this material added to the pile and the other plant-based materials measured in this study had low or non-detectable levels of mercury.

On average, the dry weight total mercury concentrations in the finished compost were about two times higher than the initial compost. However, the total mercury values for the initial compost pile are estimated while the finished compost values were directly measured. Variability in measuring the mass of the materials used to create the initial compost pile, along with using estimates of percent moisture for the fish waste and straw/hay, make it unlikely there is any real difference (especially an increased concentration in the finished pile) in mercury concentration between the initial and final compost piles. Because of mercury's properties as an element, it is not surprising that the mercury concentration would not be decreased through the composting process. Kinnunen *et al.* (2005) found a slight increase in mercury concentrations between their initial whitefish/lake trout fish waste and the final compost derived from it and a slight decrease in mercury concentrations between their initial chinook salmon fish waste and the final compost derived from it. They attributed the presence of mercury in the finished compost at similar levels to the initial fish waste to mercury being a heavy metal that can't be broken down through biological processes such as composting.

It's clear that using fish waste to make compost will result in some mercury being present in the finished compost because there is no removal mechanism for the mercury other than being diluted by adding bulking materials. But does the presence of mercury in the finished compost pose any health hazard to humans who use the compost to grow food in a garden?

The U.S. Environmental Protection Agency (EPA) issues standards for allowable concentrations of heavy metals in sewage sludge (biosolids) that can be applied to land (EPA 40CFR Part 503). EPA currently issues no standards for compost derived from anything other than sewage sludge, so using these standards is useful as a reference for comparison. The regulations include threshold values for “exceptional quality” and “ceiling limits” that determine whether biosolids can be deemed “high quality” or whether it can be applied at all to a field. In order to meet these designations, the biosolids must meet heavy metal concentration limits, pathogen requirements and vector attraction reduction requirements. The pathogen and vector reduction requirements are usually met through the process of composting. When compared to the heavy metal concentration limits, the concentrations of total mercury in the finished fish compost were about 50 times lower than the EPA 503 standards for exceptional quality biosolids (Figure 3). Exceptional quality biosolids can be applied to any type of land without any additional management restrictions. According to these standards, mercury concentrations in the fish compost in this study are low enough that the compost could be applied to soil in a garden without concern over build-up of mercury in the soil over time.

Figure 3. Mean concentration of total mercury estimated in the initial compost pile and measured in the final fish compost compared to EPA 40CFR Part 503 Biosolids Exceptional Quality (maximum mercury concentration for biosolids that can be applied without restriction) and Ceiling Limit (maximum mercury concentration for biosolids that can be applied to land) concentrations for total mercury.



Mercury was not detected in any of the corn samples taken from the test plots. Kinnunen *et al.* (2005) detected mercury at very low levels in basil plants grown in soil mixed with fish compost (mean – 0.003 ugHg/g). Metals such as mercury tend to be more concentrated in the roots of plants rather than the stems or leaves and plants grown in soil that contains low amounts of mercury do not accumulate it to a significant degree (Mitra 1986, Patra and Sharma 2000). The mercury present in leafy and other above-ground parts of plants is most likely due to foliar uptake through stomata and deposition of mercury from the ambient air (Patra and Sharma 2000, EPA 1997). A modeled estimate by the USEPA predicts that about 79% of mercury in plant products is inorganic, with the rest being primarily methylmercury (EPA 1997). Many factors such as type of plant species, soil organic matter, soil mercury concentration, air mercury concentration and others will affect how much mercury will end up in a plant, but overall mercury uptake in garden plants is very low, particularly in plants grown in uncontaminated areas. Thus, for the purposes of gardening, neither the fish compost nor the soil prior to compost addition in this study contains mercury levels that are a concern to human health.

ACKNOWLEDGEMENTS

I would like to thank the many people who were involved in making this project happen, including Tom Cogger with NRCS, Camilla Vargas and the Americorps Vista Volunteers, Jason Fischbach with UW-Extension, the folks at Bjork Wood Products, Tom Markee and LSRI, Neil Kmiecik, Shane Cramb, Butch Mieloszyk and Ed White with GLIFWC and U.S. EPA for providing funding for mercury testing. This was a fun project and I hope the results will be useful.

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APPENDICES

Appendix 1. Soil Test Report: Lawn and Garden. UW-Madison Soil and Forage Analysis Lab. April 2007.

Appendix 2. Lake Superior Research Institute (LSRI) Quality Control and Compost Mercury Data. August 2006.

Appendix 3. Lake Superior Research Institute (LSRI) Quality Control, Compost Mercury and Percent Moisture Data. October 2007.

Appendix 1

Soil Test Report: Lawn and Garden. UW-Madison Soil and Forage Analysis Lab. April 2007.

Samples Analyzed By:
Soil & Forage Analysis Lab
8396 Yellowstone Drive
Marshfield, WI 54449
(715) 387-2523

SOIL TEST REPORT
LAWN & GARDEN

COOPERATIVE EXTENSION
University of Wisconsin-Extension
University of Wisconsin-Madison
Department of Soil Science

Lab Number: 755 **Date received:** 4/4/2007 **Account:** 555004 **Client:** Matt Hudson, GLIFWC
PO Box 9
Odanah WI 54861

County: Ashland **Date processed:** 4/13/2007

Send to:

Matt Hudson, GLIFWC
PO Box 9
Odanah WI 54861

Area Type
Garden/Vegetable

Area Designation
Fish Compost

RECOMMENDATIONS

Lime to Apply

No soil pH adjustment is recommended.

Fertilizer to Apply

The following summary specifies the actual amount of nutrients needed based on the results of your soil analysis. Most plants require at least an annual nitrogen application and soils retested in 2-3 years to determine if more is needed.

Actual Nutrient Need (lbs/100 ft^2)

Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
0.15	0.0	0.0

These nutrients can be applied using many different products including commonly available turf fertilizer materials. The following suggestions are provided for your reference. Avoid 'weed and feed' or crabgrass inhibitor fertilizer types.

Nitrogen: Apply 0.6 lbs of regular (high N) turf fertilizer per 100 sq-ft to meet plant nitrogen needs.

Phosphate: No phosphate fertilizer needed. Excessive phosphorus is not detrimental to plant growth but may contribute to surface water pollution.

Potash: No potash fertilizer needed. Excessive potassium is not detrimental to plant growth but adding more will not benefit crops.

For a description of fertilizer grades please see http://uwlab.soils.wisc.edu/pubs/grades.pdf

Cultural and Management Tips

Leafy vegetables, sweet corn, tomatoes, and vine crops may require additional nitrogen at flowering. Place about 1 oz (2 Tbl) urea or 4 Tbl of a high nitrogen turf fertilizer in a band at least 3 inches from the plant. Use 1.5 lbs (3 cups) urea or 3 lbs (6 cups high nitrogen turf fertilizer) for every 100 ft or row.

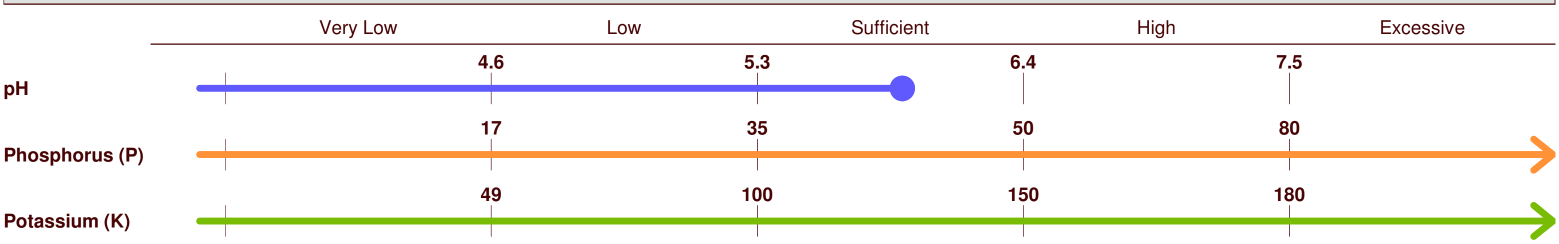
If growing a scab susceptible variety of potato a lower pH is desired. For additional information contact your County Extension Office.

References and Resources

For additional information on garden fertilization please see http://uwlab.soils.wisc.edu/gardens.htm

For further explanation please contact your County Extension Office.

LABORATORY ANALYSIS INTERPRETATIONS



LABORATORY ANALYSIS

Sample	pH	Phosphorus [P] (ppm)	Potassium [K] (ppm)	Organic Matter %
1	5.9	175	1,085	44.2

Appendix 2

Lake Superior Research Institute (LSRI) Quality Control and Compost Mercury Data.
August 2006.

Standard Curve Data Run Coincident with the GLIFWC 2006 Compost Pile Analysis.

Analysis Date	Standard Conc. ng Hg/L	Blank Corrected Abs 1	Blank Corrected Abs 2	Blank Corrected Abs 3	Blank Corrected MEAN	Std. Dev.	Correlation	Slope	Intercept
8/3/06	0	0.0015*	0.0014*	0	0.0000	0.0001			
8/3/06	50	0.0011	0.0012	0	0.0012	0.0001			
8/3/06	100	0.0026	0.0037	0	0.0032	0.0008			
8/3/06	500	0.0128	0.0139	0	0.0134	0.0008			
8/3/06	1000	0.0250	0.0263	0	0.0257	0.0009			
8/3/06	6000	0.1465	0.1464	0	0.1465	0.0001	1.000	2.43E-05	0.0006
8/3/06	0	0.0014*			0.0000				
8/3/06	50	0.0013			0.0013				
8/3/06	100	0.0027			0.0027				
8/3/06	500	0.0140			0.0140				
8/3/06	1000	0.0276			0.0276				
8/3/06	6000	0.1552			0.1552		0.9999	2.58 E-05	0.0006

* Absorbance values for 0 ng/L standards are actual absorbances measured. Zero is used as value for blank concentration in calculating the standard curve.

Sample ID	µg Hg/g
Compost -Fish -1	0.203
Compost -Fish -2	0.231
Compost -Fish -3	0.207
Compost - Leaves -1	0.026
Compost - Leaves -2	0.027
Compost - Leaves -3	0.023
Compost - Sawdust - 1	<0.0042
Compost - Sawdust - 2	<0.0042
Compost - Sawdust - 3	<0.0042
Compost - Wood Chips-1	<0.0042
Compost - Wood Chips-2	<0.0042
Compost - Wood Chips-3	<0.0042
Compost - Wood Chips-3 dup	<0.0042

The samples highlighted in green correspond to the standards highlighted in green. These were digested and analyzed following standard procedure.

The samples highlighted in blue correspond to the standards highlighted in blue. These samples and standards had an extra 5 mL of potassium permanganate added during the digestion.

Duplicate agreement cannot be calculated because both samples are less than the detection limit.
Spike recovery for sample Compost - Wood Chips - 3 was 95.7% and 95.8%.

Appendix 3.

Lake Superior Research Institute (LSRI) Quality Control, Compost Mercury and Percent Moisture Data. October 2007.

Mercury in Compost and Corn Samples	
	Hg Conc.
Sample	(µg/g)
Creekwood-1 Corn	<0.0047
Creekwood-2 Corn	<0.0047
Creekwood-3 Corn	<0.0047
No Compost-1 Corn	<0.0047
No Compost-2 Corn	<0.0047
No Compost-3 Corn	<0.0047
Fish Compost-1 Corn	<0.0047
Fish Compost-2 Corn	<0.0047
Fish Compost-3 Corn	<0.0047
Fish Compost Pile-1	0.139
Fish Compost Pile-2	0.229
Fsih Compost Pile-3	0.153
Garden Plot Soil-1	0.018
Garden Plot Soil-2	0.022
Garden Plot Soil-3	0.019

	Spike
QA Samples	**Recovery**
Fish Compost Pile-1	91.7
Fish Compost-1 Corn	100.1
DORM	101.1
DORM	100.1

Percent Moisture Analysis-Compost and Corn Samples

	Pan	Pan + Wet	Pan + Dry	Wet Tissue	Dry Tissue	Percent
Sample	Wt. (g)	Wt (g)	Wt (g)	Wt (g)	Wt (g)	Moisture
Creekwood-1 Corn	1.027	3.750	2.577	2.723	1.550	43.1
Creekwood-2 Corn	1.037	3.640	2.525	2.603	1.488	42.8
Creekwood-3 Corn	1.048	3.993	2.744	2.945	1.696	42.4
No Compost-1 Corn	1.041	4.424	2.833	3.383	1.792	47.0
No Compost-2 Corn	1.048	4.257	2.725	3.209	1.677	47.7
No Compost-3 Corn	1.057	3.862	2.531	2.805	1.474	47.5
Fish Compost-1 Corn	1.035	4.341	3.113	3.306	2.078	37.1
Fish Compost-2 Corn	1.020	3.677	2.654	2.657	1.634	38.5
Fish Compost-3 Corn	1.048	4.066	2.902	3.018	1.854	38.6
Fish Compost Pile-1	1.032	3.106	1.937	2.074	0.905	56.4
Fish Compost Pile-2	1.045	3.780	2.270	2.735	1.225	55.2
Fsih Compost Pile-3	1.010	4.030	2.344	3.020	1.334	55.8
Garden Plot Soil-1	1.024	3.260	2.918	2.236	1.894	15.3
Garden Plot Soil-2	1.020	3.497	3.121	2.477	2.101	15.2
Garden Plot Soil-3	1.036	3.727	3.317	2.691	2.281	15.2